Precision
SHOOTING
Dealing exclusively with the topic of extreme rifle accuracy

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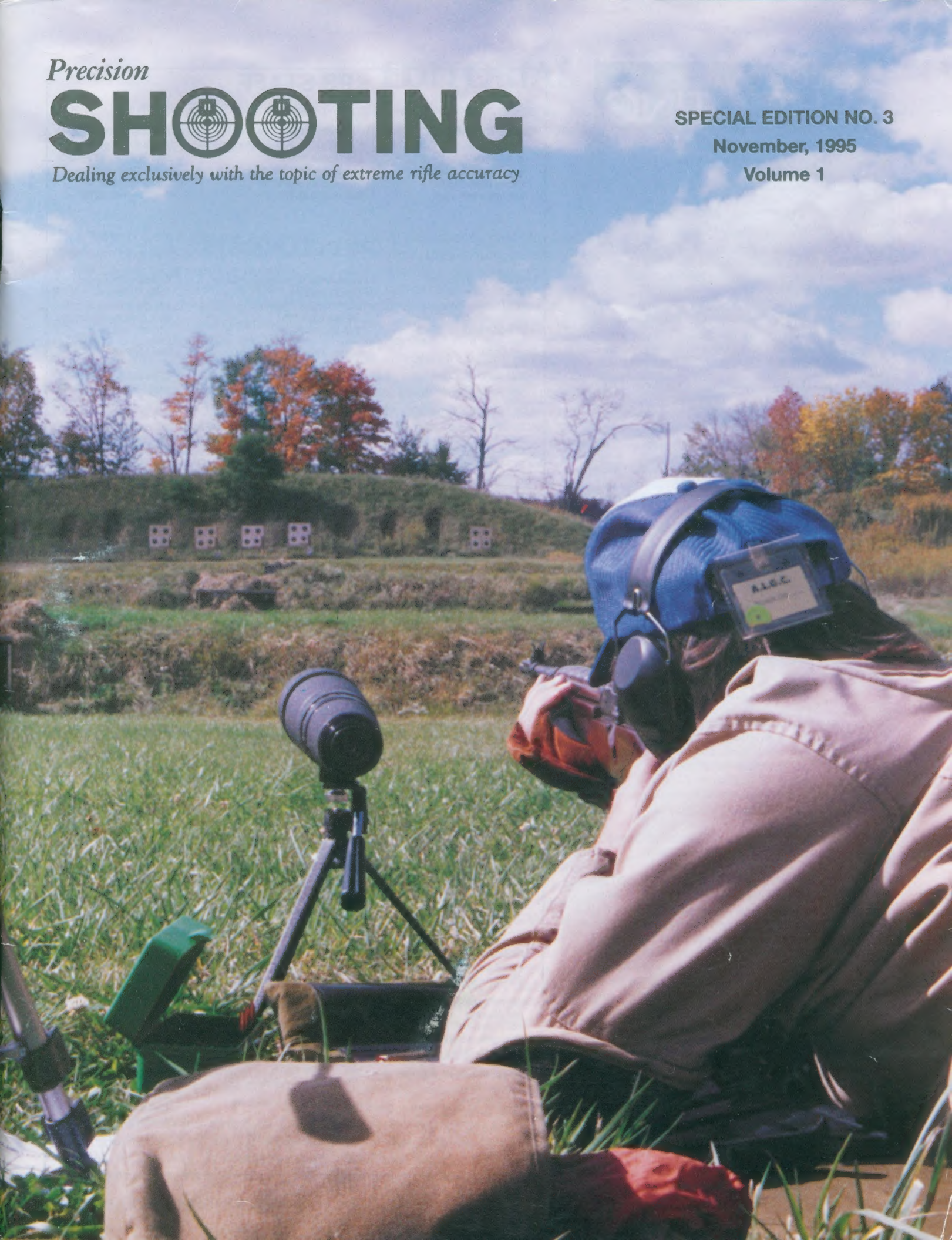

PRECISION SHOOTING™

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EDITORIAL

It was sinful that Ronald Reagan ever became president. Most of the time he was an actor reading his own lines, who didn't understand his own programs... but let me give him his due. He would have made a hell of a king.

Tip O'Neill

Two short years ago we published Precision Shooting Special Issue No. 1, at the urging of a modest number of readers, who were of the opinion that with the Holidays at hand, what with all the credit card debt being run up at a dizzy and depressing pace... the visits by myriad relatives... the de rigueur visits to other relatives and business associates... to say nothing of the enormous pleasure to be found in opening twelve different Christmas-wrapped presents and finding tie pins in each... well, they wanted something to escape to. The names of a few good single-malt Scotches were on the tip of my tongue when it occurred to me that they were thinking in terms of *something-substantial-to-read*.

Since we were piling up a certain backlog of articles at the time, and certain of our writers felt that a two or three month delay in seeing their Contribution to the World of Knowledge come into print was more than they could possibly cope with... there's a one to two year delay at many competitors' firearms publications, but our writers are rather insular, (and intended to remain that way)... an idea slowly formed... perhaps we can kill two birds with one stone here. Hmmm...

Thus was born Precision Shooting Special Issue No. 1, in December 1993. Actually, once we got underway, we were pleasantly surprised to find that the idea was not only workable... but it had a lot of things going for it. With no "Association News", and with the same number of advertisements now spread over 200 pages (rather than 100 pages)... we were able to squeeze 50 articles into that first Special Issue. With the benefit of hindsight, three articles in that issue have since become recognized classics of their genre, and are widely quoted today.

In December, 1994 we turned out Precision Shooting Special No. 2, with 47 articles, and once again caused several thousand shooters to ignore family and friends over the Holiday Season, with their face buried in a 200 page tome, and oblivious to threats and blandishments alike from loved ones, fellow subway riders, and the attractive lady seated on the next bar stool.

All of this caused us to have to rethink the whole matter. I mean... where is our real obligation... to a relatively small number of shooters... or to "family values" and domestic tranquility through this great land of ours? The matter called for deep reflection and consideration.

We are happy to bring you Precision Shooting Special Issue No. 3... which we hope you will enjoy as much as (apparently) you enjoyed No. 1 and No. 2.

The Editor

MORE .223 HIGHPOWER STUFF

Dear David,

Many thanks for the September (and August) replacement issues of PS, which arrived this morning. I got NO work done as a result. Bummer.

Anyway, please send the enclosed copies of diagrams to Bill Wylde, with my compliments, and a rider that my 223 Rem Sportco target rifle won that County Open Match this August, against about 80 308s, all shoooting best handloads. **Tell Bill that the use of Vihtavuori N-140 in 223s is a trade secret, and I propose to sue him for billions for spilling the beans.** We use 27 grains N-140 in 223 Rem for all bullets from 40 to 70 grains. The reasons are two:

1. It's impossible to stuff more in the cases, and

2. The accuracy is phenomenal.

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2. For mass-loaded ammo to 1,000 yards, Hornady 68 gr BT-HP #2278, 1/2MOA all the way. We usually use Winchester cases, Rem 7-1/2 primers (are they amazing, or what?), and expect 3,140 fps from our 26" Border Barrel 1-10" twists. No kidding, all them with 308s just surrender when they see us appearing with our 223s! And yes, you can tell Bill that our next 223 Rem barrels will be 1-9" twists, because we think we know how close we are to the brink of instability. Like C-L-O-S-E.

And tell Bill from me that it was all because we read some of his earlier jottings that we had a go at 223 Rem target rifles in the first place, just for fun. This means that he is going to get sued TWICE. Once by me as above for squealing about N-140 powder (that's the first $2billion), and then by my darling wife for causing all that extra mess she has to suffer (that's another $3billion). So. If Bill wants to take the easy way out he can send me a ~~cheque~~ check for $5billion, and we will be able to avoid all that time wasting litigation, and save him the legal fees too. Generous to a fault, I am.

But on a more serious note, please tell Bill Wylde from us over here that we would not have had all our pleasure, or many of our amazing victories, had it not been for his articles, and his vision. We are truly grateful to him for his works, and can underwrite and confirm his works to the full. As a result of his work and ours, the 223 Rem is right on the brink of "arriving" over here as a fully fledged and fully competitive target rifle. And Bill Wylde started it! Thanks a lot Bill!!

Best wishes,
Charles F. Young

COVER PHOTO

The photos on both Volume I and Volume II of this year's Special issue No. 3 are the handiwork of Precision Shooting's Staff Photographer Don Ballasch, and were taken on local Ohio ranges. No big name shooter, no big name match involvement here. But fall is in the air... the leaves are turning... the air is crisp... and (remarkably) the bullets today are going where the shooter, and Sierra intended for them to go all along. What a delightful day!

More on Freezing

by
Bill Brawand

Dear Dave,

After reading the editorial page of the April issue, I thought that you might be interested in the following...

In June of 1991 a fellow from Michigan by the name of Paul Pauliwich contacted me, to order some 78.5 grain .25 caliber bullets. Enclosed is a target that he later sent to me. The bullets had been frozen, and in addition a used .25 caliber barrel was chambered for the 25 BR, and then frozen. Thus, both bullets and barrel in this case had been frozen.

I called Paul and asked if he could freeze a 1000 yard barrel, to see if the treatment would help it. While I was talking to him he indicated that in his testing of frozen bullets he was finding that they turned up groups that were 30 thousandths smaller than groups fired through the same barrel with unfrozen bullets. Statements of such a nature tend to get the attention of any red-blooded benchrest shooter!

I received my barrel back in about two weeks. On my practice range I shot a 1000 yard group that measured 5 1/4". I then went off to Williamsport, and fired ten shots that were both small group and high score. For obvious reasons I was of the opinion that the frozen barrel helped!

I later told Phil Sauer about my experiments. He in turn had two barrels that were cut from the same bar of steel. One barrel was frozen before it was drilled and rifled. Then both barrels were drilled, reamed, and button rifled. Phil then chambered them both, and he told me that the frozen barrel cut easier and smoother.

He then took each barrel and put it on his unlimited class rifle. He proceeded to shoot 100 rounds through each rifle without stopping. Over a period of two weeks he fired five 100 round strings through each barrel. At the end of this 500 round torture test the frozen barrel looked brand new, but the untreated barrel was really burned. Phil told me that firing 100 rounds without pause left the barrel so hot that he was sure that he could have fried an egg on it!

I thought that you, as well as others, might be interested in a little bit of what already has been done in this just-starting-up field.

Bill Brawand
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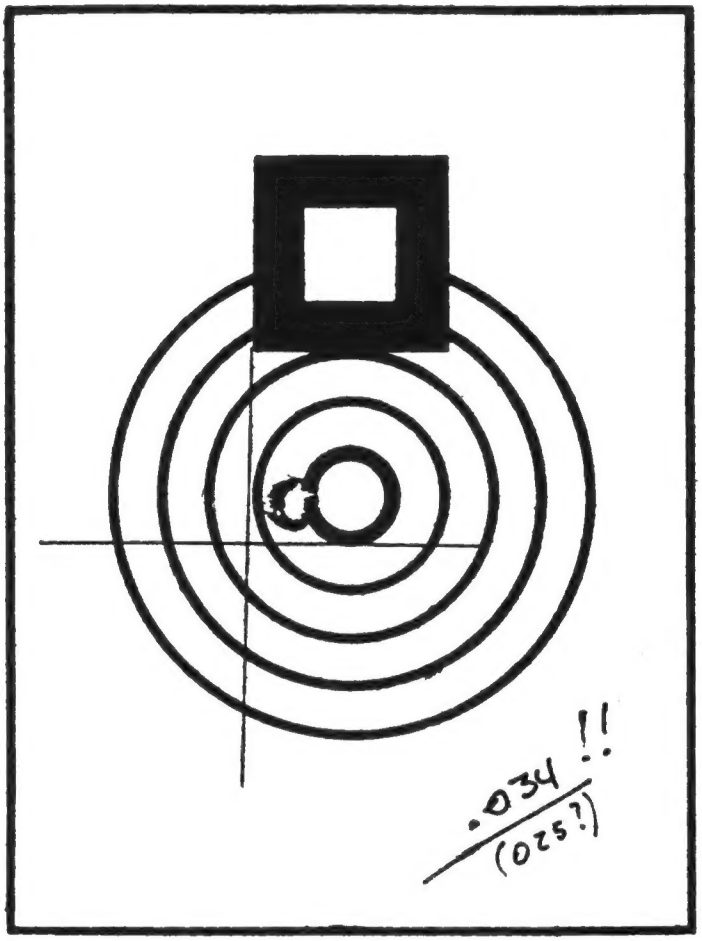

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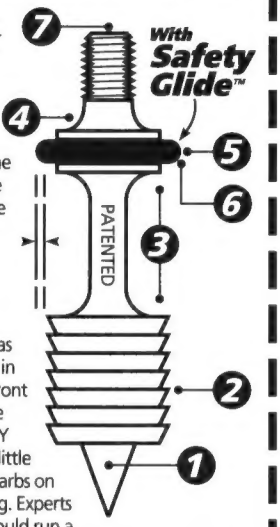

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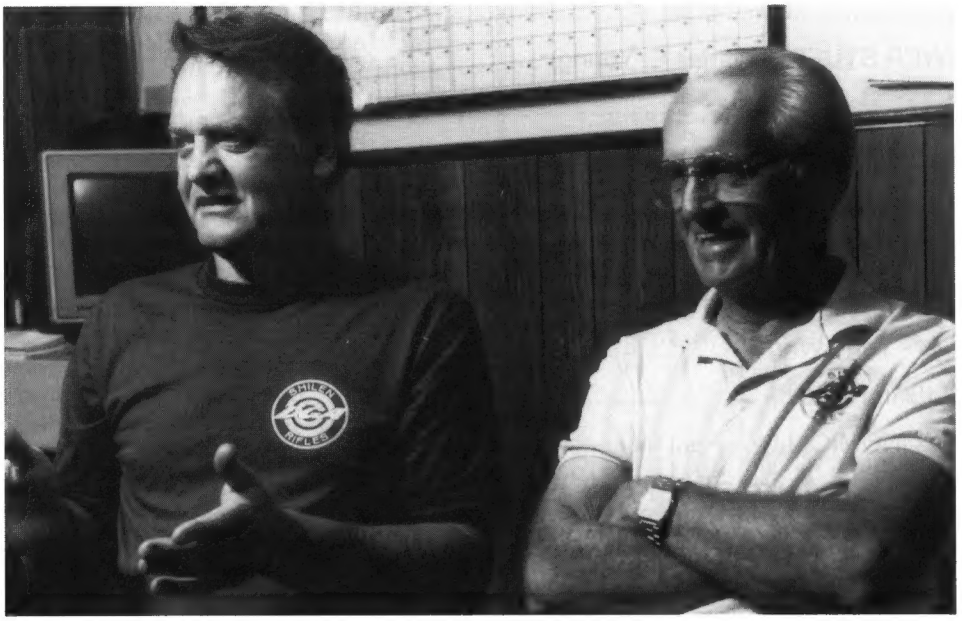
The Shilens on Accuracy

by

Dave Scott



Doug Shilen, left, and Ed Shilen field questions with patience and good humor, interspersed with puzzling fits of laughter.

As we shooters struggle to squeeze every last bit of accuracy from our rifles, we accumulate theories based on our limited experiences. Unfortunately, our experiences and the resulting theories are precisely that: limited. Indeed, most of us have been denied the pleasures of serious tinkering with a wide variety of rifles. Alas, the nagging distraction of putting cereal on the table tends to severely limit one's play time, even if the funds were available for frequent gun purchases.

These harsh facts of life, however, don't apply to everyone. I'm struck by the realization that Ed and Doug Shilen see more rifles on their way to the Mr. Coffee than I've piddled with in my lifetime. More to the point, the two Ennis, Texas barrelmakers have examined and diagnosed the problems of several thousand ailing rifles. What have father and son learned in nearly 40 years of poring over every conceivable rifle? What conclusions have they reached in inspecting, reworking, rebarreling and testing literally tons of guns? What can the elder Shilen, who, at one time or another, has owned 13 world records in benchrest competition and resides, with a handful of sandbag deities, in the Benchrest Hall of Fame, tell us about accuracy?

Recently I succeeded in cornering both Shilens in the relative quiet of Ed's office — a task not all that simple. In my yellow note pad I had scribbled scores of questions. I desperately hope some of my inquiries include ones you would have added to the list. Let's indeed see what Ed and Doug Shilen can tell us about rifles and accuracy.

What are the most common causes of inaccuracy in factory rifles?

Doug: We used to offer a service where we did diagnostic checks on factory guns. The primary areas we checked were the bedding and barrel. In the barrel we looked for problems with the concentricity of the throat, the inside surface finish and the crown. We also measured the grooves to see if the dimensions were within nominal specs — not oversize or undersize. We checked to see how square the front of the receiver was with the barrel and if the barrel shoulder was making contact with the face of the receiver all around. Other things we checked were the firing pin protrusion and mainspring pressure. In bedding, we looked for how much flex was created when the guard screws were tightened, thus flexing both the stock and receiver at the same time. This creates problems with barrel vibrations. Bedding is the biggest problem we see in factory guns — bedding done by the factory. In fact, the factories have found that meeting their accuracy criteria is best done by putting a pressure point on the barrel, which gets more consistent accuracy.

Ed: Bedding stress can either bend or twist the receiver, or both. A rifle will deliver its best accuracy only when you get this out. It's been known for many years that on a factory bolt gun if you put a little upward pressure between the end of the forend and barrel, the gun will usually shoot better. If this happens on your gun, it means the receiver is not bedded stress free.

In a hunting rifle, do you always want the barrel free-floating?

Ed: Yes. That way you're going to get the most consistent point of impact under hunting conditions. If the forend is bedded against the barrel, different amounts of sling tension, resting on sandbags or over a log will all be different from shooting offhand and will affect your point of impact.

How can we make factory rifles shoot better?

Ed: In our experience, we've found the

most important factors are what we call the three B's — barrel, bedding and bullets. By "bullets" we also mean the load, which has to be worked up by the shooter. If the barrel looks good and you've bedded the action properly, that rifle should shoot pretty well.

What if it doesn't?

Ed: This can get very complicated because there are some highly technical problems that are not readily noticeable that will keep a gun shooting terribly, no matter what you do. What we recommend is if the barrel looks good and you've bedded the gun and worked up handloads, and still the gun doesn't shoot well, it's time to get rid of it.

Why?

Ed: Because to fix it is probably going to be very costly. Action truing is time-consuming and expensive, and not every gunsmith truly understands what the process is all about.

If a receiver has internal stresses in the metal, will this harm accuracy?

Doug: Where you see problems is by inducing stresses from outside sources, such as improperly attaching the barrel and scope or uneven bedding. Did you ever attach a one-piece base, and when you tightened the screws at one end, the other end sticks up? Well, when you screw that end down, there you go, stressing the action.

Any new thoughts on Hummer Barrels?

Ed: The kind of accuracy they're getting out of benchrest rifles is nothing short of unbelievable. However, I believe a Hummer is a combination of a lot of things coming together at one time. A Hummer may do better in the wind. If so, I suspect it involves the bullet being spun by a given twist on a given day. Remember that as the air density and air pressure change, so does the twist requirement for a specific bullet. In short, there are so many variables involved, you just can't put your finger on one thing and say this is what causes a Hummer Barrel.

Is there any benefit to working with bullet-seating depth?

Ed: Yes. Take a rifle that's shooting well and seat the bullet 10 to 15 thousandths deeper or farther out and you'll see a difference in accuracy. When tuning a benchrest rifle, I start with the bullet just barely touching the lands, then experiment both ways. It seems like whether a rifle shoots better against the lands varies with different cartridges. For instance, years ago we used to shoot the standard .222 Remington with bullets jumping a little. Then we got into the PPCs and seems like they shoot best touching. This may have something to do with the cartridge design, or it may be the particular chamber, throat dimension and angle of throat.

If a rifle's best accuracy results from seating the bullet far off the lands, does this indicate a chamber alignment problem?

Ed: Experience tends to indicate that this is true. Seems like most factory rifles shoot better with the bullet jumping just a little bit. Maybe this gives the case neck time to open up and allow the bullet to enter the throat a little straighter. In other words, if there's some misalignment between barrel and chamber, it gives the bullet a chance to align itself.

Doug: Speaking of bullet seating, it amazes me that the average shooter doesn't know the difference between reloading and tuning. Reloading is going through the motions of putting powder, primer and a bullet in a case, relying on data from a reloading manual. Tuning is making ammo that gets the most potential accuracy from a rifle.

What does the angle of throat land taper play in accuracy?

Ed: On average, most chambers use 3 degrees per side. The benchrest guys decided to go with 1-1/2 degrees per side. I've never proved to my satisfaction that this is any better.

Will the steeper, 3-degree taper give longer barrel life?

Ed: Not necessarily. The general theory is that the angle of the lands should match the bullet ogive. This is why they went to 1-1/2 degrees on the benchrest cartridges. That angle most closely matches the ogive of today's match bullets. Years ago, Harvey Donaldson published a drawing showing how he went in and lapped the throat, using bullets for laps, until the leade was exactly the same shape as his bullets. I still don't know how he did it, because I tried it and it didn't work. I just made a mess out of the throat. He must have known something I didn't.

Do some barrels shoot better fouled?

Ed: That's a hard question to answer. We're going to have to get into some basics here. All barrels foul. I repeat, *all* barrels foul. If they didn't, we wouldn't have to clean them. You just can't push a dry jacketed bullet through a dry bore without some fouling. Any barrel will accept a certain amount of fouling without showing a decrease in accuracy. It's only when fouling gets excessive that you start having accuracy problems. You start out shooting a clean barrel, but after a few shots you get a little fouling. This will gradually get worse and worse until accuracy goes downhill. It takes a little bit different load to get the best accuracy from this same barrel after it has attained some fouling. So if a load is developed for a barrel in a fouled condition, after cleaning you may have to foul the barrel again before it really starts shooting. In most cleaning, we never get 100% of fouling out, so all we're doing is taking out the excess. If you start out with a clean barrel, after a single shot it'll have a gray coating, particularly in the back end, that looks like soot from powder. You can theorize all you want on what happens next. Some people say the next bullet blows all the soot out. Another group says nothing that sticky can be blown out, and the next bullet just irons right over the top of that.

How much fouling can build up if the barrel isn't cleaned?

Ed: Fouling will continue building up if it's not removed. I've seen barrels with the grooves completely filled. One I particularly remember was a Weatherby with the grooves in the last 6 inches of the muzzle end completely filled. Needless to say, it was not shooting well. It was keyholing.

Doug: The more important question is, which one causes the fouling: the barrel or the bullet? If you're a bulletmaker, barrels foul. If you're a barrelmaker, bullets foul.

Why does a barrel with tight and loose spots shoot poorly?

Ed: You have to visualize what happens to a barrel as the bullet passes through it. The barrel is in what I call the whip stage. It's not vibrating at this point but is deforming or whipping. It's very similar to a water hose when you turn on high pressure. If a bullet goes down the barrel in a constant acceleration, the barrel will whip much the same way every time. But if you have tight and loose spots, either due to dimensional problems or lots of fouling at various points, then that destroys the whip pattern and makes it inconsistent. Of course, all this is theory. To my knowledge, no one has

Continued on next page

The Shilens on Acccuracy

Continued

ever been able to measure all this stuff. They've tried with oscilloscopes and strain gauges, and they just don't know.

Wouldn't the bullet base expand and then squeeze down as it traveled a barrel with inconsistent dimensional uniformity?

Ed: Apparently, a jacketed bullet doesn't expand inside the barrel. A theory I've heard many times is that when the barrel is oversize compared to the bullet you get blowby around the bullet, and this acts like a welding torch, melting the jacket material and causing fouling.

What happens inside a barrel when it "shoots out"?

Ed: When a barrel is shot out, you loose both the lands and the grooves. Tremendous heat is generated in the barrel with every shot, with the highest temperatures right in front of the chamber. Although the temperatures are in excess of the melting point of the metal, the process lasts such a short period of time that erosion is really the result of only a shallow layer of surface metal getting burned. The erosion occurs as the little pieces of burned, charred, cracked metal flake off.

Why does this harm accuracy?

Ed: As we discussed before, lots of times you can tune a gun to shoot better by letting the bullets jump a little bit. But I've never seen a gun shoot well when you begin jumping excessive amounts. I consider anything over 1/16" excessive, because I've never seen a rifle with that much jump shoot well. In fact, if you jump bullets more than this, accuracy gets worse and worse. You can create this situation either by cutting a chamber with a long throat, known as freebore, or by barrel erosion. In a rifle with good lands, the farthest I ever went back and saw it do any good was about 1/32".

Why is consistent barrel twist so important?

Ed: An inconsistent rate of twist does the same thing as tight and loose spots in a barrel. As the bullet goes through a barrel, it doesn't like anything that makes it abruptly slow down or speed up — and we're talking about both forward and rotational speed. But if the change is very gradual, the bullet doesn't seem to mind. For example, a true gain-twist barrel starts out with no twist at all, then at a very constant increase you wind up with, say, a 14" twist, and these barrels shoot great. By the way, you can imagine what kind of engraving a gain-twist barrel would make on the bullet!

Is tightness of the bolt in the boltway important?

Doug: I've seen receivers where the front end of the bolt was such a loose fit in the receiver bore that I could reach in through the front of the action and move the bolt nose around maybe 20 thousandths. If every time you open and close the bolt it closes one time on the top and the next time on the bottom, the angularity of the bolt face is changed and that can cause accuracy problems. Of course, if that same bolt is consistent in how it closes, the looseness doesn't really hurt anything. So the situation is really circumstantial.

Ed: No one has ever been able to give a definitive dimension as to how tight or loose a bolt should be.

Doug: As the bolt is closed, the trigger mechanism and firing pin spring pressure tend to push the back of the bolt up and the front down. If you have 10 thousandths between bolt and body pretty consistently, it will tend to lock the same each time. But if you have, say, 20 thousandths, as you close the bolt it's also trying to kick sideways, and it may not want to close the same every time. Many shooters consider only the fit of the bolt at the rear bearing area, but it's the fit at the front of the action that's most important. There's a theory that bolt locking lugs should be lapped in with the trigger removed and pressure applied from the front. You can lap the lugs for perfect contact this way, but when you put the trigger back and close the bolt, then the lug contact is no good. We believe the best way to lap in lugs is to use the trigger and the pressure of the firing pin spring.

How important are the receiver's barrel threads?

Doug: It's very important that the threads be straight and perpendicular to the face of the receiver. By the same token, if you cut the barrel threads too loose for the receiver, you have problems. The same is true if they're cut too tight.

Are short barrel more accurate than long barrels?

Ed: I think barrel tuners have very well proven that there is no such thing as an ideal barrel length. There may be an ideal barrel length for a particular rifle with a specific load and bedding. But when you change anything, the length is no longer ideal. While I believe barrel length has to fall within a certain window, any length in that window will give the same accuracy. The most practical thing to do is specify the length you want and tune everything else to match it.

Why is a heavy barrel more accurate than a light one?

Ed: Who says a heavy barrel is more accurate?

Doug: The accuracy potential between a barrel measuring 1/2 inch at the muzzle and one measuring 1 inch is the same from a mechanical standpoint. But from a practical standpoint, with the 1-inch barrel the shooter isn't fighting so much barrel whip and therefore can find an accurate load more easily.

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Ed: One of the killers of accuracy is recoil. Because the gun is recoiling while the bullet is going through the barrel, how you control recoil until the bullet gets out is a big factor. The heavier the overall gun, the easier it is to control the recoil. This may make it appear that the heavy gun is more accurate than a lighter one, but technically this may not be so.

Doug: Another big factor is heating. With light barrels, which heat faster, you may see accuracy problems. What's happening is the load is changing because the barrel's internal dimensions are growing. Because heat makes the inside of the barrel larger, the bullets in effect grow smaller, which changes pressures. This means you have a choice of developing a load either for a hot barrel or a cold barrel. Most of the time we develop loads for cold barrels.

How important is the crown?

Ed: Extremely. You have to have a very clean exit for the bullet. If you have burrs up there, it'll raise hell with accuracy. The rifling and grooves also have to be very uniform right to the extreme edge of the muzzle.

Is there a best type of crown?

Doug: No, but it has to be perfectly square to the bore. It's easier to get a precise crown job in a lathe if you take a straight, perpendicular cut rather than an 11-degree cut. With a straight cut, even if the barrel isn't indicated in exactly true the edge of the crown will be perpendicular. On the other hand, if you cut an 11-degree target crown, and it's not exactly true, then the profile of the hole will be elliptical.

Should a barrel be recrowned now and then?

Doug: Only if it's been scraped or dinged, or damaged by a cleaning rod. Just shooting doesn't necessitate recrowning.

Would there be any advantage to stress relieving a barrel after it's been threaded, chambered and crowned?

Ed: We can take a barrel blank, and even though it has already been stress relieved at the foundry it may have residual stress. Then, as an experiment, we can drill, ream and rifle it, leaving off our stress relieving process entirely. Even so, that barrel is going to shoot really well. I've never seen a case where we took a barrel that was shooting bad, stress relieved it, and it shot any better. And we've tried it many, many times. Some gunsmiths use barrel stress as a convenient "out" when they can't find the real problem with the rifle.

Are extremely tight throats helpful to accuracy?

Ed: From what I've seen, throat diameter doesn't seem to matter so long as the throat is not too tight. If it's too tight it will actually shear or peel metal from the side of the bullet. The important thing is that the cone of the throat is concentric to the bore. That's what seems to get the bullet started straight in the barrel.

Would an extremely long and tight throat configured for seating the bullet in the extreme end of the case neck achieve better accuracy?

Ed: Long throats with the bullets seated out in the end of the neck have been tried as far back as I can remember. Several times, various experimenters may have thought they saw a difference, but the results are inconclusive, as far as I know. Sam Wilson used to cut a long throat and manually insert the bullet into it. He used paper wads to hold the powder in the case. It shot okay, but it was lots of work.

How do you hold a benchrest rifle?

Ed: I use what is generally called a light hold. I don't shoot free-recoil, but I also don't bear down. I put the butt against my shoulder but with no amount of pressure, just kind of touching. I put my hand on the grip, but don't use a death grip.

How do you hold a factory hunting rifle?

Ed: With factory guns with lighter stocks, 20 years ago I found a good technique of holding the gun really tight and pulling it into my shoulder.

Are stiff, rigid stocks more accurate?

Ed: I've never been able to tell that rigidity of the stock made any difference at all, except that it does make a difference according to your shooting style — how hard you hold onto the gun and so on. Some shooters get better results with stiffer stocks, others with not-so-stiff.

Doug: Let's say you have a really stiff stock, and you've got your hands around the pistol grip, thumb up over the top strap. A certain amount of weight is flexing the stock. If you're good at repeating that pressure, you'll shoot well, but if the stock flexes more, any inconsistency in pressure will be more critical. If you shoot free-recoil, it probably doesn't matter whether the stock is stiff or not.

What type of bedding is best?

Doug: All types of bedding are equally good, all will give equal levels of accuracy if done right.

Ed: I've always felt it was a good idea to remove a glue-in now and then and reglue it. We also found that sleeves that were installed on actions years ago act screwy and need to be taken apart and reglued.

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A FEW NOTES
(from a shadetree mechanic)
on
TUNING THE RUGER NO. 1

by

John F. Herold

In reading P-S Magazine for the past several years, the subject of tuning or accurizing the Ruger No. 1 seems to come up periodically, most recently in the last Holiday Supplement issue in which Merrill Martin describes his method of attaching the forearm and buttstock for best performance. My earliest printed reference to doing anything in this regard was found in "Rifle" Magazine, in the July-August, 1969 issue (Issue No. 4). In that article, the author recommends installing a neoprene washer between the forearm and hanger in order to relieve pressure on the barrel. Over time, several recommendations have directed that a setscrew adjustment be installed in the tip of the forearm hanger to regulate pressure on the barrel at this point. This all tells me that the tinkering and experimenting has been going on for a good while now, and probably won't stop soon. Apparently, the rifle's good looks tend to belie a few inherent performance problems.

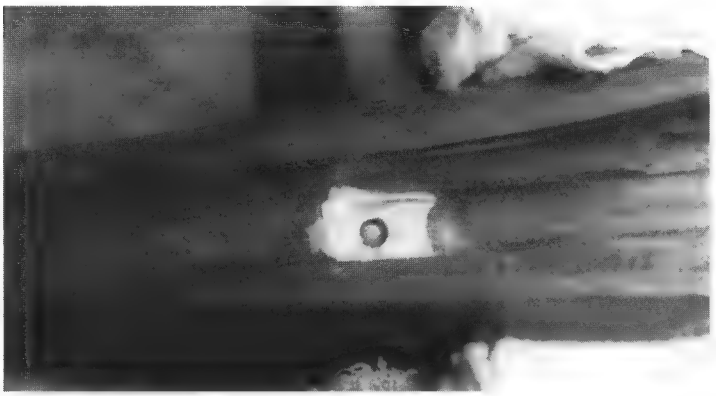
I'll admit to being a late comer to the discussion, since my personal indepth relationship with a recalcitrant Ruger began only in January of 1991, when I took delivery on a (then) limited edition No. 1-S in .218 Bee. I lapped the Ruger rings, installed a favorite Leupold 12x and waited for decent weather. When I could finally find my club range again (that was probably around March if I remember correctly), the Ruger showed off its inherently cranky nature in spades, stringing everything I fed it all over the paper. Vertical stringing was the gun's favorite trick, but it wasn't above throwing in a bit of horizontal group movement just to keep things interesting. Back home again, and down in the dungeon, er... shop, this time, I began the laborious process of figuring out just how in the blazes to make the darned gun shoot decent groups. ....More than once, I even considered caressing it with a four-pound bronze hammer I keep for special occasions..... One tried and true magic incantation after another failed miserably. What follows, then should by no means be regarded as 1) a criticism of anyone else's methodology in the area, or 2) anywhere near the last word on the subject. There are often several workable solutions to any given problem, and this is simply mine, worked out over a period of time and found to work fairly well on a relatively small number of different guns. It's presented here as an example of another workable solution that PS readers might want to consider.

Since the forearm area seems to be where most of the jarring and jumping go on in the Ruger, that's where my first efforts were directed. I'd heard that drilling the forearm hanger for a setscrew was the traditional way to go, since that would allow for varying the pressure on the barrel, but, for reasons of my own, (I wasn't interested in doing anything permanent that couldn't be undone) I decided to try to get along without that. Instead, a method evolved which I believe serves much the same purpose, although it differs a bit from others that I've seen. It gets a bit complicated, (although I'm sure P/S readers have no problem dealing with complication.... Indeed, they seem to thrive on it) so bear with me, please.

The problem, in a nutshell, involves vibration. When the hammer is cocked, the mainspring is compressed along the axis of the forearm hanger. As soon as the hammer begins to fall, this compression is relieved, and the hanger probably begins to move somewhat, although not very much, if my observations are correct. The mainspring and strut move to the rear and down as the hammer rotates. At the end of the stroke, however, when the hammer nose "crashes" into the "hammer transfer block" transferring its energy to the firing pin, all sorts of vibrations reverberate back along the hammer strut and spring to the forearm hanger. The spring expands, stops suddenly, and then recoils in a wave pattern.... kind of like the undulations of a "slinky" toy. The breechblock itself also vibrates (you can feel this with your thumb as the hammer falls) and tends to work upward if there is any slack in its lockup (and there always is in factory Rugers.) In short, everything that should not be moving is, and at exactly the wrong time, if accuracy is the goal. This combines with what Merrill Martin and others have referred to as "stick-slip" motion between the forearm and barrel as this vibration takes place, In an attempt to measure the relative amount of vibration present, I rigged an indicator to the barrel, with the point on the tip of the unsupported hanger. I was able to notice the needle flutter about .015" on the vertical and about .005" on the horizontal plane as the mechanism was dry-fired several times (without the forearm in place.) Apparently then, there is motion on both axes when thing get going. From what the limited number of indicator "flutter" readings appeared to tell me, this vibration is pretty consistent from shot to shot in the bare, unsupported hanger: i.e. the indicator needle swung through the same arc each time.

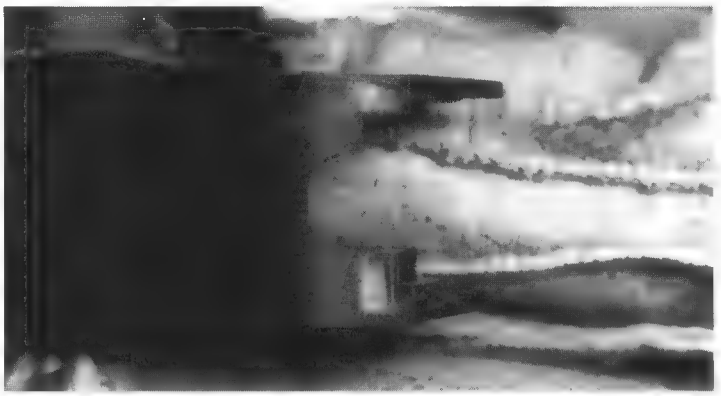
The trick, therefore, to any mounting system in the forearm would appear to be to 1) make sure the vibrations are the SAME for each shot as nearly as possible, 2) dampen the vibrations as much as possible and in a manner that does not introduce any other inconsistencies to the process, and 3) make sure that the various parts involved (i.e. the barrel and forearm bedding surfaces) come to rest in as nearly the same relationship as possible for each shot. The bedding method described here has worked well for me in both a light-barrelled gun (the 1-S) and in a heavier barrelled gun, the 1-V. I haven't tried it on anything with a heavier barrel than the factory provides, and I can't speak first-hand for any of the other methods I've read about, so I'll leave the reader to determine for himself which system gives him the best results in his

My Cluttered Shop. Better not publish this one. (Editor: Nonsense....)



Front of forearm hanger is bedded to fully contact at its tip.

These small areas at rear of forearm are bedded to contact the rear of the forearm hanger.



Areas routed for bedding pads on underside of forearm.

particular shooting situation. And I've only dealt with low-recoiling guns in varmint calibers in this respect. It might be expected that rifles generating more recoil (and vibration when fired?) might be expected to behave differently, perhaps settling more normally after each firing cycle as regards the forearm "stick-slip" phenomenon, since the increased recoil might provide greater vibration. I'd be interested in finding out how this system works on a large-caliber gun for comparison, if anyone wants to try it.

Shooting with the barrel totally free of the forearm proved pretty hopeless, since the forearm and hanger then just bounce merrily up and down together on the rest with no restriction.... not much accuracy there, at least with the forearm rested on a sandbag. It's about like having a forearm made out of spring-loaded spaghetti. Likewise, allowing the barrel to contact the forearm along its sides didn't help, since everything is just "stick-slipping" anyway.... evidently the more of the barrel surface in contact with the wood, the worse things get. Now here is where Mr. Martin's system and mine differ: Both appear to achieve stiffness in the forearm setup, just in different ways. In Mr. Martin's method, the forearm is carefully bedded to the hanger, and then to the receiver face, which stiffens the setup by using the receiver as a brace at right angles to the hanger motion. The barrel is then protected from much vibration by the forearm's being installed out of contact with it, except for an insulating layer of silicone rubber material. In "my" system, the barrel is made an integral part of the vibrating parts assembly, and vibration is dampened or reduced by means of "preloading" the forearm hanger and forearm against the heaviest part of the

Continued on next page

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TUNING THE RUGER NO. 1

Continued

barrel to produce a setup not unlike the Ruger factory assembly, but differing in a couple of important details, as described.

Bed the forearm according to the following instructions:

STEP 1: Remove the mainspring and strut, and the ejector spring mechanism from the forearm hanger. With the factory forearm in "as-is" condition, using a small dental burr on a Dremel or Foredom tool, carefully rout out depressions in the horizontal flat surfaces on the two small tabs at the rear of the forearm, (the ones that bear upward on the root of the forearm hanger) down to a depth of at least 1/8". Leave a small amount of wood to support things here while the bedding material cures. Then establish an area for a bearing pad in the forearm channel, about 2" long and 3" ahead of the tip of the hanger. Apply release agent to the metal, and bed these two areas, with the forearm screw snugged barely tight.

Yes, I know... most people bed the forearm at the tip, and the Ruger factory does, too. However, bedding a bit farther back I think helps to better damp the vibrations since it's being done at a thicker and hence stiffer part of the barrel; and this way the pressure point ends up the same distance from the two rear "pads" as is the front of the hanger. That way, the vibrations work on the barrel with less mechanical advantage. Try it. I was pretty well forced to do this on the short-forearmed 1-S, but I later found it works out on the 1-B's and V's too.

STEP 2: After the bedding in Step 1 hardens, remove the forearm carefully. You'll notice that it has to be slid FORWARD a half inch or so in order to remove it, since the two pads at the rear tend to keep the forearm from rotating downward. Now, apply release agent to the end of the forearm hanger, and the screw and nut. Again using a Dremel or similar tool, rout out the area in the inletting where the hanger tip rests, being sure to deepen it somewhat. Apply bedding material to the last half inch or so of the hanger channel in the forearm where the hanger tip will rest. Don't overdo this, since if you slop bedding over into the area between the hanger and barrel, it can make things *verrrry* hard to get apart. Better use too little material than too much the first time around. Install the forearm and tighten the screw. You're setting the forearm pressure on the barrel here, so tighten the screw enough to give 6 to 10 pounds of upward pressure on the barrel (or as much or as little as you would like to experiment with.) I've found that noticeable, even heavy upward pressure here is what is required for best shooting, at least with sporter weight barrels. Apparently, this "preload" condition helps to dampen and regularize the vibrating forearm hanger. I believe, too, that allowing vibration to reach the barrel through the wood probably leads to a less "sharp" impulse and may be beneficial to consistency. Compare this to the action of a tuning fork: Get the tuning fork vibrating, touch it with your fingers, and the tone stops. Touch it with a piece of metal however, and you get all sorts of noise as the parts bounce off each other.

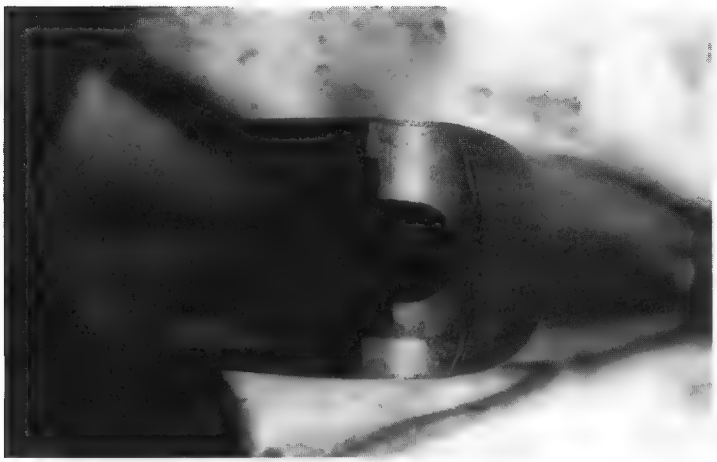
STEP 3: Remove the forearm again, and trim the bedding done thus far. Make sure that none has leaked up into the area where the hammer spring and strut move, and make sure that the end of the forearm hanger bears fully at the end of its channel in the forearm. Now, prepare two small bedding areas, one on either side of the curved lower rear portion of the forearm, to mate up with the protruding curved "shelf" at the front of the receiver, and directly underneath the two "pads" that were bedded in Step 1. Take two tiny scraps cellophane tape, .002" or so thick, and place them carefully, one on either side of the forearm screw hole at the front of the curved vertical surface of the hanger tip bedding. This shims the forearm temporarily forward a couple of thousandths while the bedding hardens in the two lower rear pads. Apply release agent to the receiver shelf and bed these two pads. Tighten the forearm screw and allow the bedding to set up. When cured, disassemble the forearm again and remove the two shims. Now, when the forearm screw is tightened, the forearm is wedged securely at its rear, since the upper and lower rear pads are at an angle and the forearm wedges tight here as the screw is tightened.

STEP 4: Relieve the rear vertical faces of the forearm to barely clear the receiver. Do this *carefully*, since you run the risk of splintering or chipping the wood's end grain here. I like to use a fine cut 6" mill file for this, working slowly on either side until there is an even .003" or .004" gap between wood and metal. Use a feeler gauge to check progress, and don't overdo it, or an unsightly gap will result. At this point, the forearm is tightened fully against the bedded area at the hanger tip, supported by the bedded pads at the rear of the wood, but free of the vertical receiver face otherwise. Now, relieve the inletting along the sides of the barrel channel. I usually apply a strip or two of cellophane tape along either side of the barrel, and apply Prussian Blue to that. Carefully scrape away the high spots with a small curved scraper (the traditional "blue and fit" method), and an even line all around will result. Remove the tape and clean up the metal, and then seal the unfinished wood surface with tung or linseed oil. If the edges of the inletting look slightly chipped or rough, you can gently round and polish these to a more "factory" look by going over the edges lightly with a piece of crocus cloth. Don't sand through the finish, just polish things up a little.

With the forearm bedded this way, the gun will simply *not* shoot with the rear of the forearm touching the receiver face. I've tried it. Apparently this contact interrupts the process of the barrel and forearm moving smoothly and regularly together, so a small gap here is what's necessary.

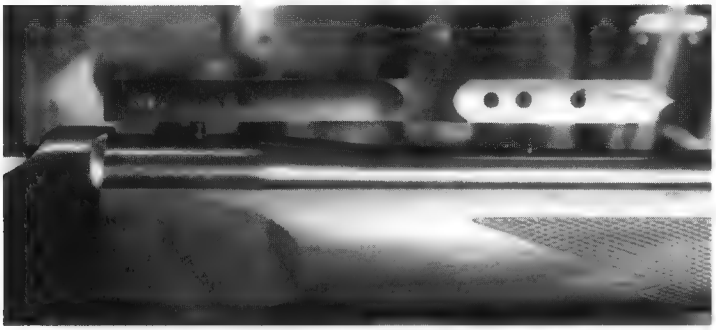
To help overcome the "stick-slip" condition that results as the forearm pressure point moves on the barrel, use moly grease, or an anti-seize product such as "Never Seez" (available in auto parts stores) or one of the shotgun choke tube thread lubricants. My thanks to the late Creighton Audette for this original tip. He recommended using moly grease on an epoxy bedded job, or dry moly powder rubbed into the wood on a job where the wood is left bare. A little dab spread around on the forward pressure area between epoxy and barrel will keep things sliding nicely for quite a while. Regular grease or oil will dissipate rather quickly under constant static pressure here, so be sure to use a grease with very high particle content such as the above. The particles tend to stay put longer. And by the way, Never Seez also seems to work excellently on bolt lugs. Has anybody else tried it for this?

With this treatment applied to the original .218 Bee, groups were much smaller, but sometimes would still move erratically as the barrel heated up. Now and then, if conditions were just right, I could still get a nice 3" vertical group with a half inch or less horizontal dispersion. More commonly, though, a group of 3 or 4 shots would cluster nicely, and one or two would be outside the group, usually high or low. The only thing left that I hadn't fooled with was the barrel rib, and I'd dreaded the thought, since the 4 screws that attach it are more often than not the most miserable little sob's to get loose that I've ever encountered. They're 8x36 threaded flat head cap screws, with

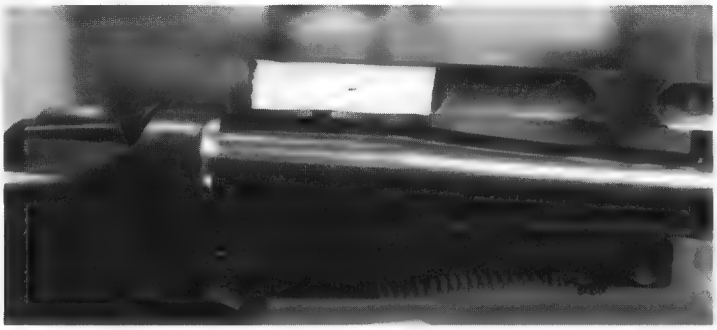


Finished bedding pads on underside of forearm.

Small gap at rear of forearm.

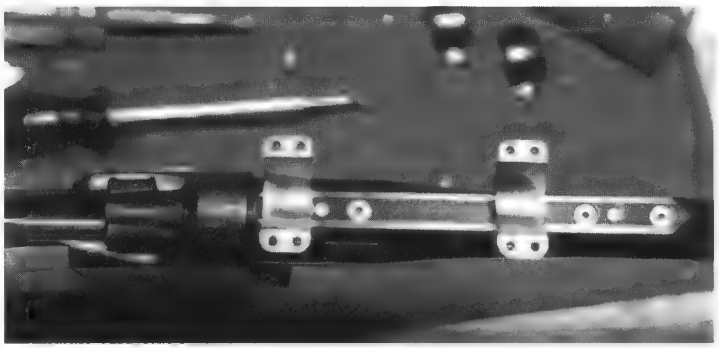


Mating surface of rib was filed to more closely match barrel contour prior to glassing.



A piece of Teflon tape under rear rib pad allows for barrel to expand without binding during firing.

Finished rib installation.



Partially lapped scope rings.

a tiny 3/32" hex socket, so they won't stand much serious wrenching, and as often as not the sockets strip before the screws come loose. The wide screw heads seem to grip the countersunk area in the rib for all they're worth, and I'm sure that's what Mr. Ruger had in mind. Just to be on the safe side, I ordered up a couple of spare sets of screws from Ruger, and when they arrived, I went to work. As I anticipated, I bent one allen wrench, broke another, and only man-

Continued on next page

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TUNING THE RUGER NO. 1

Continued

aged to work two of the four screws loose in the process. I drilled the heads off the other two, as expected.

The rib was still securely held on the barrel by the two 3/16" diameter dowel pins, and required some finagling with "padded prying instruments" to finally remove. [OK, Mr. Editor. Time for more comments about shade tree mechanics or whatever... give it your best shot. Remember my 4-pound bronze hammer.] I guess that "too tight" would have to be the verdict here, wouldn't you say? I also noticed that the mating curvatures of rib and barrel weren't a particularly good match, and that the rib actually bent somewhat as it was tightened on the barrel, just like a badly fitted one piece scope base on a bolt gun receiver. With the two front screws tightened, the rear of the base was about .050" shy of touching the barrel. Now how about that?

To relieve some of the binding, I elongated the rear dowel pin hole with a 3/16" chain saw file. Then I filed the underside of the rib to more closely match the barrel contour. The contact areas were then degreased and filled with black-dyed epoxy. With some release agent on the barrel and screws, the rib was placed back in position. When the epoxy was about half cured and still pliable, I trimmed the excess from around the joint, making the whole joint next to unnoticeable. I hadn't been apprised of the "stick-slip" theory of things rubbing on the barrel until I corresponded with Creighton Audette and read Merrill Martin's article, but serendipitously [I guess that means that I "discovered" this all by my little old self] figured that if the barrel was expanding as it heated and the rib was binding tightly, then this was probably screwing up accuracy. I was right [OK again, Mr. Editor. No, I probably wouldn't say anything if I were wrong.] To keep things slipping, I used a 1/2" wide piece of teflon tape under the rear mounting pad, and tightened the two front rib screws a bit more than the rear ones. I also used a wisp of Teflon tape under the screw heads to ease disassembly.

The work on the rib mounting finally brought the long-sought consistency. Groups at last, with ammunition the gun liked, were hovering around 3/4" at 100 yds., and the Bee was performing well enough to take groundhogging. I even managed a couple of "fluke" groups under 1/2" at 100, and point of impact generally maintained itself well between groups. I'd recommend at least checking the rib fit on any of the "B" or "S" series guns that use the one-piece rib, and with the "V" series guns using two-piece bases, I'd recommend glass bedding the bases to the barrel and carefully lapping the scope rings to remove any unwanted tension in that setup.

Now that the gun was shooting well enough that I could tell the difference, I noticed that it was a bit ammunition-sensitive, too. In particular, during several chronographing sessions, I noticed that it was a relatively easy matter to assemble ammo that gave 10-round extreme velocity spreads of upwards of 160 fps. in a string. This seems to be a little-known "curse" of certain small rounds such as the Bee and the Hornet, and may be due as much to cartridge design as to gun design. The muzzle obviously moves during the firing process, and the bullet probably exits at a different point in the cycle as velocity and barrel time vary. I used AAC 1680 powder, prepped Winchester brass, and Remington #7 1/2 primers with a Hornady 45-gr. Hornet bullet for most shooting, and I noted a curious thing: As charges varied upward to a certain point, Es dropped and accuracy improved. Past a certain level, Es increased and accuracy dropped off again. I found that if I could keep the Es under 100 fps., accuracy would range from OK to extremely good; over that, and a certain amount of vertical stringing would return. Now, I realize that an Es of 100 fps. is scoffed at by shooters of other precision calibers [and yes, I know... the Bee isn't noted for being a "precision" round] but it seems that in the small tapered case with its 15-degree shoulder, it can get pretty difficult to reduce Es to the level of a PPC. The tapered case design just doesn't seem to burn powder all that consistently. That's why we have fat-bodied, sharp-shouldered cases today, right? Probably something the Hornet shooters should keep an eye on as well. I wonder how something akin to the Browning BOSS system would work here.

Undoubtedly, some of the Es problem is due to the Ruger's relatively sluggish hammer fall, combined with the energy-robbing transmission of motion through the transfer block to the firing pin. It would be interesting to see a full engineering workup on lock time, firing pin energy, etc. on this gun, but I'm not the technical wizard to supply it, I'm afraid.

I understand also that the gun's hammer can be lightened to decrease lock time, but again, I decided against drilling the necessary holes in mine. Just chicken, I guess. Instead, I installed a heavier mainspring, available from Brownell's, and called it good. Now, I haven't done any comparative velocity testing to determine the relative merits of the springs, and I probably should, but it does seem to have helped things just a bit in the accuracy department. It hasn't hurt anything and was certainly cheap enough. Along with all the above, I was also able to finagle a fairly decent trigger job for the No. 1, and can elaborate if anyone wishes. However, the esteemed Editor informs me that such things are fraught with liability pitfalls, so I'll leave any in-print ramblings on that subject alone for the time being.

Another little "trick" that I'm afraid the jury's still out on involved rebuilding the mainspring strut. The factory strut is a stamped part, and flat from front to rear. I built a cylindrical rear part and soldered and pinned a cutoff front part together in an effort to control the spring vibration (much the same concept as applied in match conditioning an M-14 in which the flat recoil spring guide is replaced with a round one.) In one gun, this seems to have had a slight beneficial effect, but in another, no effect was noticeable. I'm told that this also increases the total weight of moving parts when the hammer falls and may thereby contribute in a minor way to the action's sluggishness.

These few modifications have seemed to work well in the limited number of guns I've tried them on, but as anyone knows the real acid test is whether or not a large number of users find them beneficial over a considerable period of time. I'll leave that part to others, although I'd be interested to hear of any results or further suggestions readers may have on this subject.

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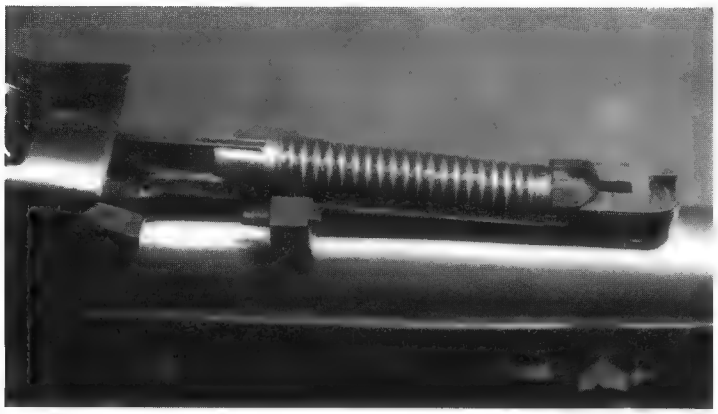
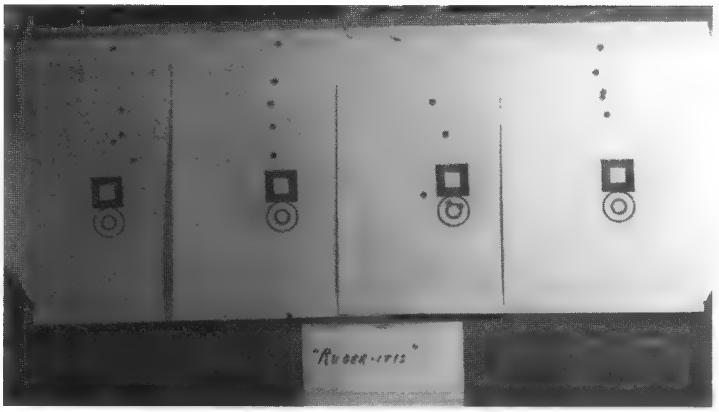
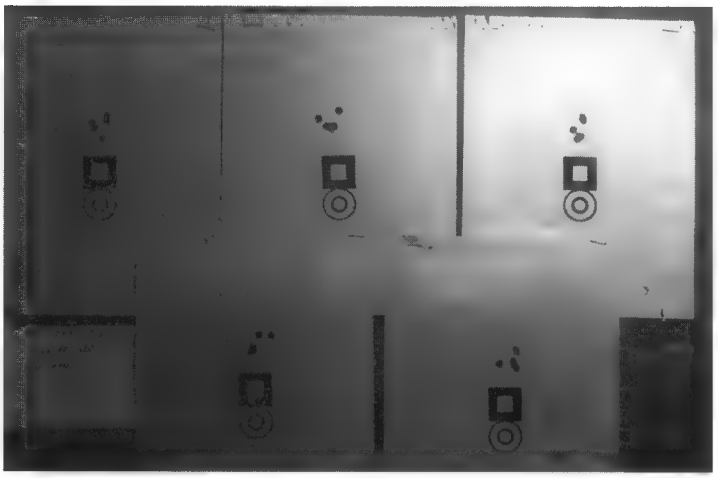


Modified hammer strut.

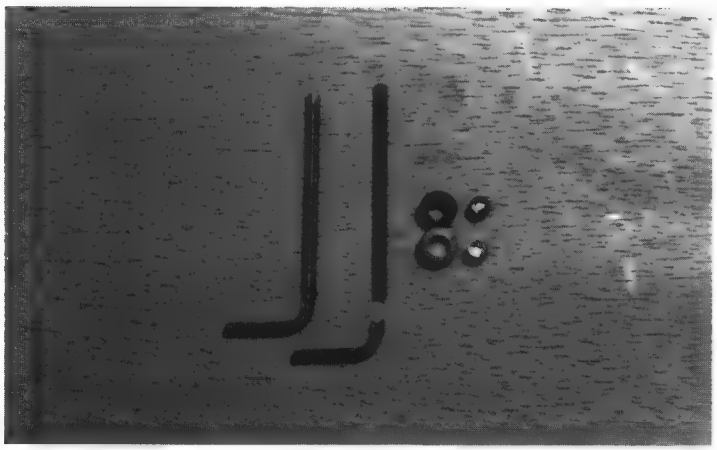


These groups are for real!!!! The gun actually shot this way before tuning!!

Groups fired after tuning .218 Bee.



More groups after tuning.



Aftermath of Ruger No. 1 rib removal: 1 bent wrench, 1 broken one, 2 drilled-out screws. Great fun, huh?

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BEWARE THE FRUMIOUS HANDSTOP RAIL

by

Randolph Constantine

The week-end after the Glorious Fourth, I shot in a slightly odd highpower match. It was the Colorado State Service Rifle Championship. All Service Rifle Championships should be so odd. What makes this match different is that the match is not restricted to Service Rifles! There is a special division for those people who want to shoot match rifles. The match rifle division even has some prizes, but, of course, a person shooting a match rifle cannot win the match and be declared the State Service Rifle Champion. One of the reasons for allowing match rifle shooters to compete is that a portion of the proceeds from the match goes to support the Colorado Junior Highpower program, so the more shooters we have, the more money we get for the juniors.

During this match I had a rifle problem that cost me somewhat more than 20 points. This problem could have been avoided if I had known something that is apparently widely known by long-time Highpower shooters. I'll describe it and the solution in all its (figuratively) gory detail. First a little background.

Because of its location and timing relative to when the Highpower matches begin at Camp Perry, the Colorado Service Rifle Championship with Match Rifle Division attracts a fair number of well-known western shooters such as Mid and Nancy Tompkins, Bob Jensen, and David Tubb, none of whom shoots a Service Rifle.

This year, David is shooting something that almost could be a Service Rifle. It looks sort of like an M16 on steroids. It is a Stoner SR-25 in 6.5-08 and it really shoots. David is having to work out a few kinks with the rifle, tuning some spring strengths so it will work reliably in the rapid-fire stages, but it is a tackdriver. I have now seen him shoot it in two matches and he has had to shoot at least one alibi in a rapid-fire match each time. When he gets it tuned up, look out.

Many other shooters have gone to the 6.5-08 cartridge as the one giving what they think is the best balance of low recoil for the rapid-fire stages combined with good bullets of high sectional density and ballistic coefficient for 600 yard shooting. We shall have to wait and see what comes out of the Camp Perry crucible this year.

The Colorado Service Rifle Championship match is held at the Buffalo Creek Gun Club Range, which happens to be one of the most beautiful ranges in the country, if not the most beautiful. The range is located 11 miles back in the Pike National Forest from the town of Bailey, Colorado and is in the middle of the mountains of the Front Range. At least one of these to the northwest still had snow on it as of 9 July. Some of the pictures in David Tubb's book, *Highpower Rifle,* were taken at the BCGC range; see pages 114, 137-139, 153 and 166 among others. The view to the west from the 600 yard line is of a red granite formation a couple of miles away that is quite spectacular.

There was one thing missing from the match this year, and that was the Marines, and many other shooters from other branches of Service as well. Because of cutbacks in the Federal budget, the money the Marines and other branches used to have to send their top shooters to civilian matches was cut way back.

Used to be, Colonel Walt Smith's unit of the Marine Corps Reserve would come to Bailey for the Colorado Regional which is held on the week-end prior to the Service Rifle Championship and would stay on through the week and practice on the BCGC range. They would also work with our juniors during this week which was, of course, greatly appreciated. They would then shoot in the Service Rifle Championship which was usually won by Col. Smith.

Col. Smith has won the Colorado Service Rifle Championship so many times, most of us have taken to calling the trophy, the Smith Trophy. In case you don't know, Col. Smith is a co-holder of the national record for 20 shots in Sitting Rapid-fire, 200-18X. He has shot that score more than once, one time at BCGC.

This year the Colorado State Service Rifle Championship was won by Ed Scruggs who is a National Guardsman from Colorado Springs with a fine score of 777-18X. The high civilian trophy was won by my friend John Volk, just 4 points back with a score of 773-16X.

Now that I have set the stage, let me tell you of my disaster and how it could have been avoided.

When I got back from the Rocky Mountain Palma Matches, I pulled the barrel off my Palma gun because it had had over 4200 rounds through it and was beginning to shoot a little "loose" at 1000 yards. The groups were opening up and the X count was going down. The factory barrel in my over-the-course gun was showing some of the same signs at 600 yards. I took the Palma barrel and installed it in my over-the-course gun, replacing the barrel that had exhibited the fluky behavior I described in my 1994 Camp Perry Report (***PS***, Nov. 1994).

I had not been using a bloop tube on the Palma gun because the 28 inch barrel put the front sight far enough away from my eye that I could see it quite well, but wanted to have one on it for over-the-course use, mostly to increase the moment of inertia to make it hold steadier for Standing. I made a new coupling for the tube I had been using on the Ultramatch and had a stupid accident while fitting it to the tube.

There is an interesting feature that bloop tube couplings seem to have: they don't want to let go of the tube when you need to take the tube off the rifle. Nobody makes a rifle case that will accommodate a rifle with a 28 inch barrel which also has a 6-inch bloop tube installed, much less one with a 10-inch tube. So you have to be able to take the tube on and off the rifle easily. Usually it turns out that if you loosen one of the screws clamping the coupling to the barrel, the screw nearest the middle of the coupling, then the coupling will let go of the tube. You don't loosen both of the

screws that clamp the coupling to the barrel or you will lose the indexing of the coupling and the front sight. While I was trying to see if this worked the way it was supposed to with the new coupling I had made, it still did not want to let go of the tube. I gave a mighty pull on the tube and it finally came out and hit me on the left cheekbone giving me a small cut and nice black eye which got me lots of rude comments at the match.

I went in the house and put some ice on the eye for about half an hour. Then I went back out to the shop and took the offending coupling and stuck it back in the lathe and bored out another 10 thousandths out from the tube socket. That fixed the sticky tube problem. I should have done that in the first place.

With the rifle now having a new barrel and bloop tube, I hied out to the Durango range and sighted it in at 100 yards and then recomputed all my zeroes. This worked well enough that at the Colorado Regional, the week-end before the Service Rifle Championship, I took 1st Expert with a pretty decent score of 750-23X. Finally my X count was back up and only 4 less than Bob Jensen's match winning X count of 27.

However, something happened with my rifle in that match that was a harbinger of things to come: the screws holding the clamp plate of the adjustable butt plate stripped out of the stock, making the butt plate rotationally considerably more adjustable than I wanted. I made a field-expedient repair by stuffing match sticks into the screw holes and then replacing the screws. This held up just fine. A check of my match diary showed that I had also had to pillar bed this stock back in 1989 because the wood under the action was giving way under the pressure of the action screws. The stock is made of good walnut heartwood and is not oil soaked or anything like that. I don't know why it seems to be so weak.

I did no more work on the rifle during the week in between the Regional and Service Rifle matches, concentrating on loading ammunition.

The morning of the Service Rifle match dawned bright and clear after weeks and weeks of cold and rain. It looked as if we might actually experience a real day of summer only three weeks late. We had been wondering all Spring where the heck was all this global warming people were talking about.

Also peculiar to the Colorado Service Rifle Championship is that it is shot in the reverse of the usual order. The match starts at the 600 yard line and once the 600 yard Prone Slowfire stage is shot, everybody moves to the 300 yard line for the Prone Rapid-fire stage. When the 300 yard stage is completed, everyone moves to the 200 yard line, where we do shoot Standing before shooting the Sitting Rapid-fire. This kept me from having a bigger disaster than might have been.

I was on relay 2 and at the 600 yard line conditions were very nice. My calculated zero was not too far off, and I got centered up quickly enough that my first record shot was a 10. I shot two called 9's and two that were not on call for a new personal best of 196-8X. The two shots that were not on call were out the bottom at 6 o'clock, and I still wonder if what was about to happen might have had anything to do with that.

We moved up to the 300 yard line. Again I had to refine the calculated zero with my sighters. We went down for the first string and things were going along smoothly. This time I felt I had the right amount of sling tension and it was easy to break shots in the center. It was when I fired my ninth shot that it hap-

Continued on next page

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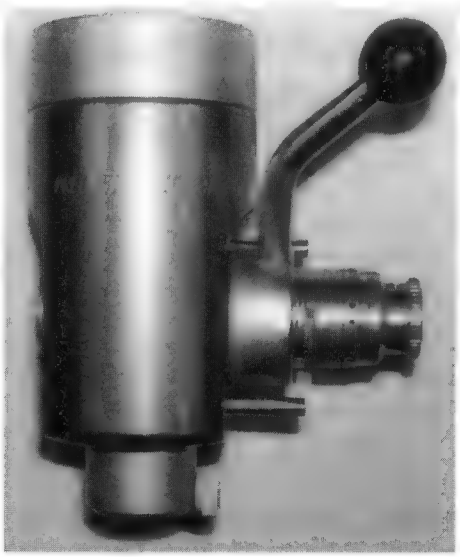

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BEWARE THE FRUMIOUS HANDSTOP RAIL

Continued

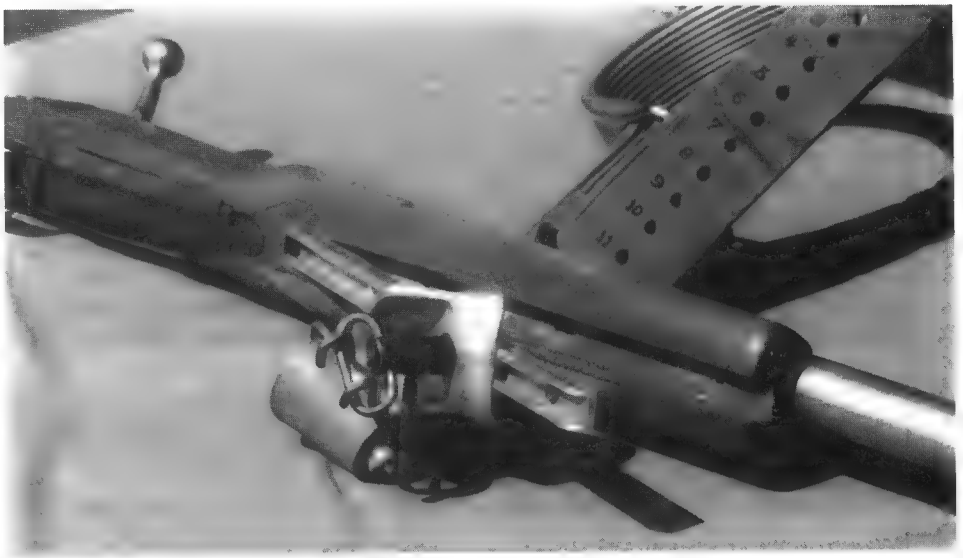
pened; the screws in the fore-end gave way and the whole handstop rail pulled down out of the fore-end and tried to become a monopod! I had a lot of time left, and floundered around, came out of the sling, and fired off the 10th shot which turned out to be 6 at 4:00. I was about 2 clicks too far to the left and ended up with a 94-0X.

As they used to say in Korea, "What chou gonna do now, GI?" I searched around on the mat and found two of the three errant screws which I frantically replaced. When the targets came up for the second string, I went down and got off one semi-good shot for an 8 before the rail came out again. Maybe the rail was already coming out when I shot that first shot, because it looked as if it should have been a 10. I tried again to shoot without the sling (I hate to shoot alibis), but it just did not work. I shot two more shots for a 6 and a miss before I gave up in disgust. I was deemed to have a disabled rifle and would get to shoot an alibi. Thank goodness, I had a back-up rifle.

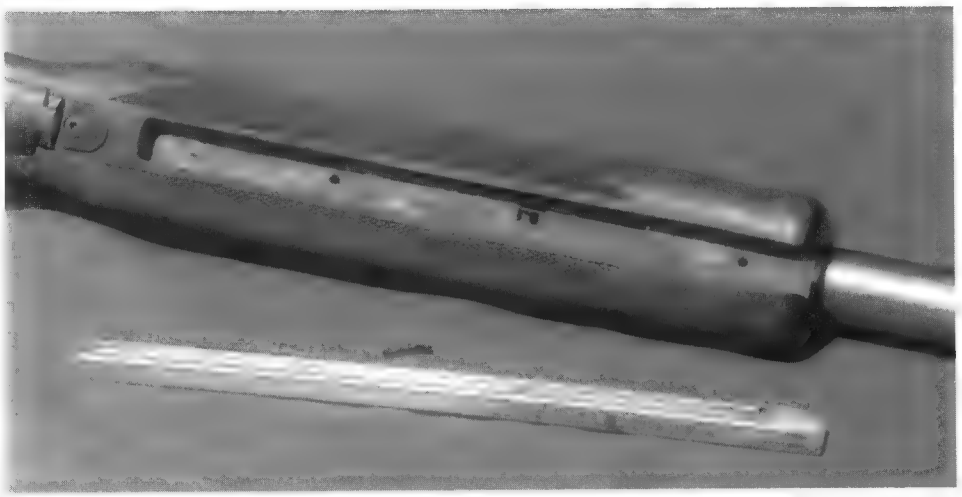
I took the sights off the primary rifle and put them on the back-up, and adjusted them for what was supposed to be the proper zero. Jim Starr, the match director, asked if I wanted sighters. Hah! Darn right I wanted sighters. I really needed them, for those old zeroes were way off for the ammo I was using. The sighters got me pretty well centered, and I shot a 96-4X for the alibi. I was not at all unhappy with that, given my state of mind.

The rest of the match did not go as well as I might have liked because the stock on the back-up is not adjustable, but it at least it did not come apart. I still managed to win 1st Expert in the Match Rifle division with a score I am almost too embarrassed to report. All right, it was a 727-15X. I managed to crossfire once during the standing because the back-up rifle does not have a bloop tube, and with where the front sight is situated on it, I cannot easily see the target numbers the way I can with the sight further out on a bloop tube. Look, I have to be able to blame my stupid mistakes on something.

After the match, I recounted my troubles to Middleton Tompkins whose reply was simply to the effect that wood screws, even with epoxy, are insufficient to hold in a handstop rail. When I talked to my friend John Van Marter about the situation, he said that he inlets a place in the barrel channel for a nut and uses machine screws to hold the rail in place.



1) How things looked when the rail came out.



2) Detail of the rail mortise. Notice the middle hole where both wood and epoxy pulled out.

Middleton's solution was essentially the same. I had already formulated a solution that might be even stronger. I am of the school that thinks that, "Anything worth doing is worth overdoing.", or put another way, "If it ain't overengineered, Murphy will find a way to break it, and at a time and place when it is most inconvenient."

My solution is to inlet a place in the barrel channel for a piece of aluminum 1 inch wide by 1/4 inch thick into which I drill and tap holes for flat headed machine screws that will hold the rail in place. The photographs show what happened when the old system failed. The rail is a Freeland rail I bought from them long ago, before they went under. In the old system I had epoxied the rail in place and then put in the 3 wood screws in the holes provided by Freeland. The epoxy was put into the screw holes as well in the hope of keeping them from backing out and to give them even better purchase within the wood of the forearm. Photo 2 shows what the situation looked like minus the shooter (me) when the rail pulled out. In Photo 3 you can see that in the middle screw hole, the epoxy pulled out with a chunk of wood to boot.

This and the way the screws came out of the butt stock in the previous match make me begin to suspect that the wood this stock is made of is deteriorating in some way. Photo 4 shows my over-engineered solution to the problem.

In any event, it is pretty obvious that Tompkins is right, that screws alone, even screws with epoxy, are insufficient to hold the rail in against the stress of the pull of a tight sling. At a minimum, you need some sort of threaded boss inletted into the barrel channel into which you screw some sort of machine screw. If my over-engineered solution gives way up at Camp Perry, I may consider making a stock out of solid aluminum.

The lesson is clear. If you are a high-power competitor who shoots a match rifle and you have the handstop rail attached to fore-end only with wood screws in the holes provided by the manufacturer, beware. That frumious rail may decide to escape from your rifle as mine did, right in the middle of a rapid-fire string, to the detriment of your score and your equanimity.

The solution is simple. At a minimum, use Van Marter's solution and inlet some nuts for 8-32 machine screws in the barrel channel and replace the wood screws with flat head machine screws. Once they are installed, grind the ends of the screws off flush with the nuts so they do not touch the barrel and then stake them in place with a center punch. You could just use Loctite®, but I am so paranoid after this that I am not sure I would trust Loctite. Maybe if you TIG welded the screws to the nuts, ...? If you are this paranoid (having seen that middle hole in Photo 2) put in something bigger than just a nut to screw the machine screws into.

A method that would be almost as strong as my 1/4 by 1 inch plate would be to make what would in essence be round T-nuts with a hole down the axis threaded 8-32 and install these in the barrel channel. This would be very easy to do on a lathe.

Some of you might be asking why 8-32, why not something larger and stronger. The reason for the 8-32 size is that it has the same head size as the wood screws that come with the rail, and the head of the screw has to fit well down into the countersink or you won't be able to slide the handstop up and down the rail. Anything larger just won't fit in the rail. *Ergo,* 8-32 is it.

It is hard to shoot well when the sling and the handstop come off the rifle. It probably even changes your zero. Although none of my other stocks has exhibited the symptoms of weak wood as has this one, my to-do list now has a new item; and that is to reinforce the attachment of the rails of my other rifles, replacing all wood screws with 8-32 machine screws. Now you know how to keep the handstop rail from escaping from the stock of your rifle. Wood screws are not sufficient. Get them replaced with machine screws that thread into something more solid than stock wood. That way you won't have to worry that your rail will try to become a monopod in the middle of a rapid-fire string.

Till next time,
Keep'em in the center,
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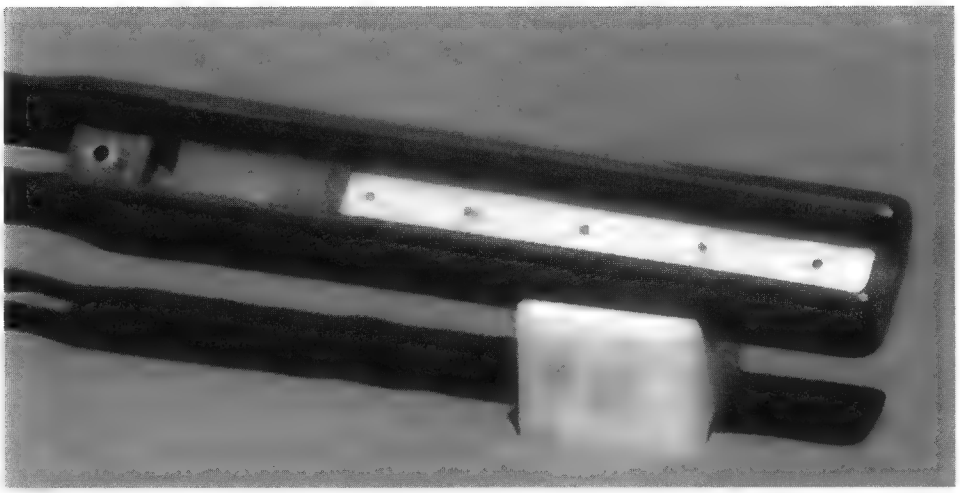
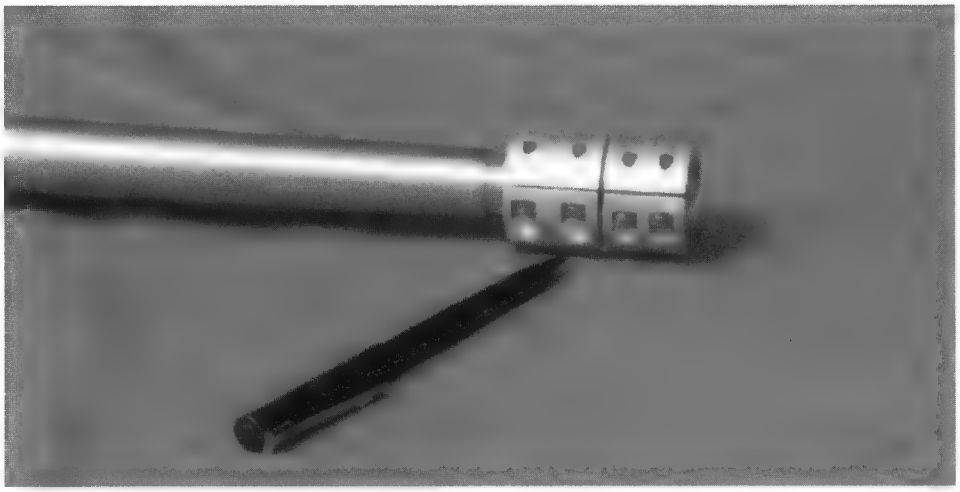


3) The "over-engineered" solution to the problem. The rail is now supported by more than 8 square inches of 1/4 inch aluminum.



4) Pen points to the screw you may have to loosen to get a bloop tube to come out of the coupling. Don't loosen the leftmost one as well, or you will lose the indexing accuracy.

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THE 7BR REMINGTON

by

Terry Wright

Last Fall I took delivery of a brand new Remington 40x-BR, chambered for the 7BR Remington.

Over the past few years I had already played with a 22BR and a 6BR, so I did not feel that I was straying into completely unknown, or particularly murky waters. The average reader of Precision Shooting magazine is pretty serious about "extreme rifle accuracy", and just might be inclined to think of the 22BR and the 6BR as being a tad overbore... which they are, at least if one accepts the 6PPC as being the yardstick against which other cartridges are measured for efficiency. With this in mind, the nagging thought occurred... is the 7BR possibly "the other way"... with not enough boiler room to get a good bullet down range with sufficient alacrity of a type needed for good groups. I had no idea in mind of a world beater, or a killer benchrest rifle. Perhaps in retrospect I was bored, and just wanted to do something different.

My interest in the BR family of cartridges goes right back to approximately 1978. Benchrest Hall of Fame shooter Jim Stekl had just fired a rather patriotic .1776 aggregate at the Pine Tree Rifle Club at Johnstown, New York (and this a year after America's Bicentennial), with a .22BR yet... a level of accomplishment with this particular cartridge that I do not believe has been approached since. The Remington catalog of that year showed the targets that made up that aggregate (.135... .152... .117... .217... .226) and, impressionable soul that I am... I soon enough decided that life would simply not be complete if I did not have one of those 40x-BR rifles with one of those big, fat stainless steel barrels. Not only that, but it had to be chambered for that neat looking .22BR... a short, fat... and ominous little piece of ordnance if I ever saw one...

In the late seventies the handgun metallic thing was starting to take hold. There were no registered benchrest matches at our range (still are not), but they were starting to shoot pistol silhouette (still do). I got started shooting pistol silhouettes, and target rifles took a back seat for a while in my life, at least for a while. In the early eighties Remington made the decision to offer the silhouette shooters an XP-100 with a 15 inch barrel.

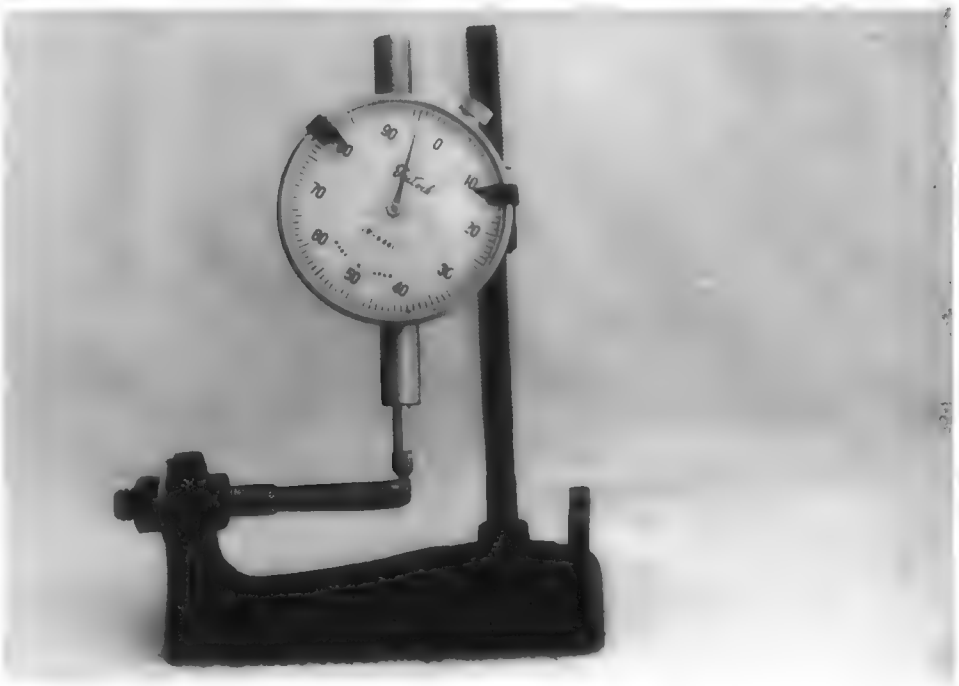

Photo #1.

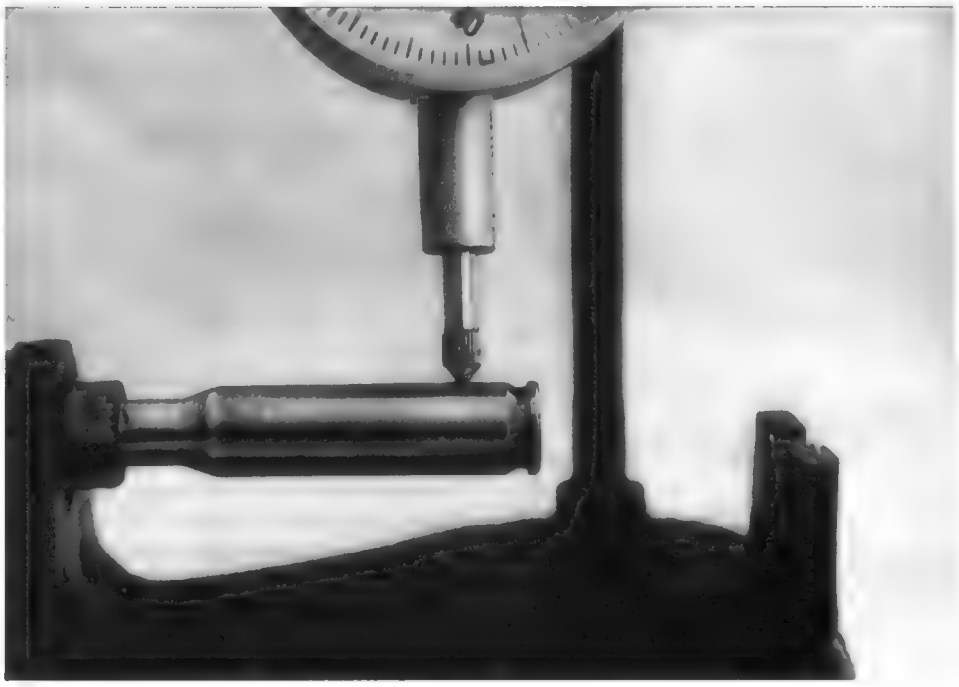

Photo #2.

Up until this point in time everybody was rebarreling 10 inch .221 Fireballs to various calibers, with 15 inch barrels. Now, not only did Remington offer the XP-100 with a 15 inch barrel, but they offered it in a new cartridge... the 7BR. Remington simply opened up the 22BR and 6BR case to .28 caliber, and the world's most

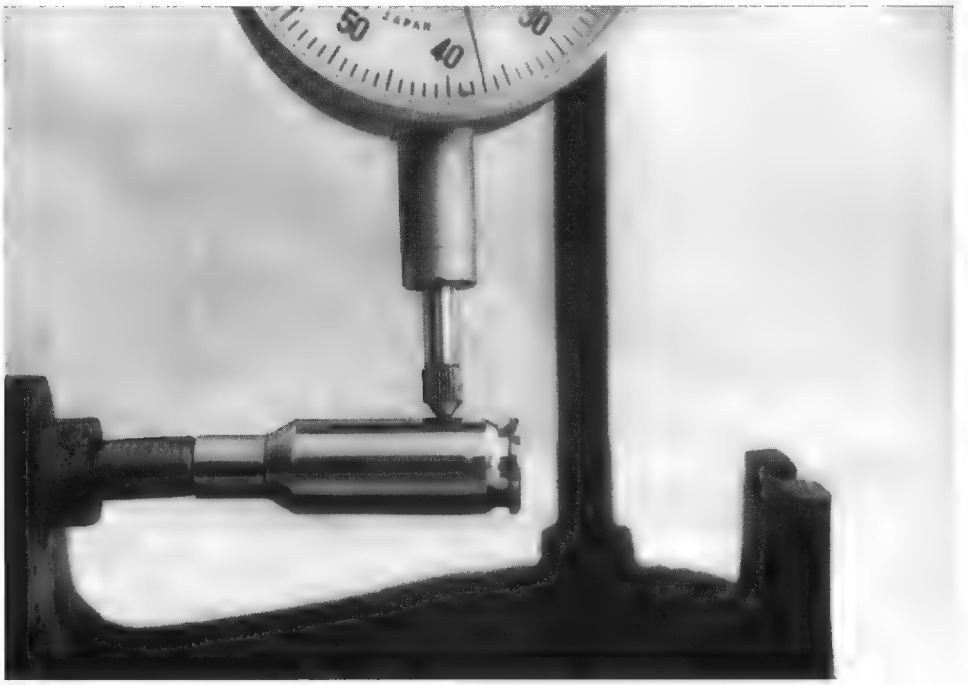

Photo #3.

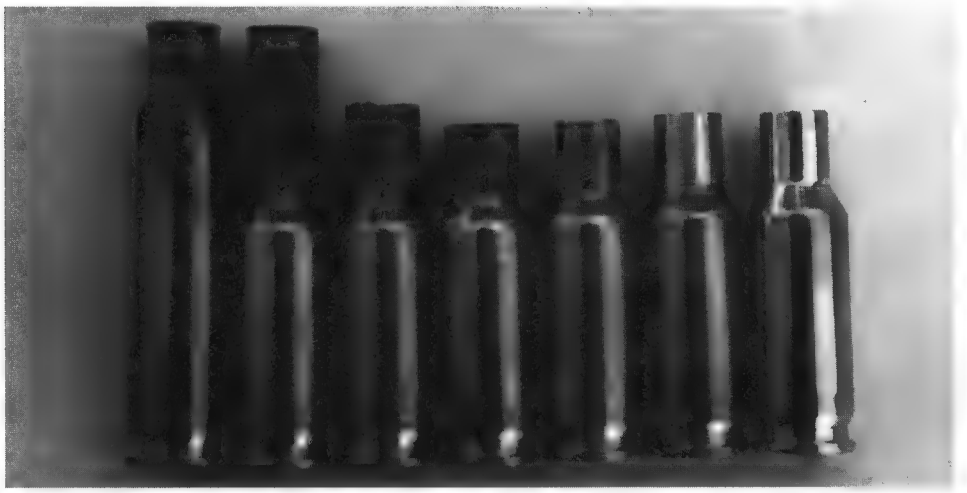

Photo #4.

popular silhouette pistol cartridge was born. It didn't start out very popular, of course. During the early days one had to make one's brass for the 7BR. But then came that wonderful day when Remington finally offered 7BR factory brass... and the picture changed completely. The popularity of the 7BR was off and running.

On to my little 7BR project; so much for history and nostalgia. Case prep was going to be straight forward (I thought). I obtained 250 cases of basic .308 brass (small primer) from Black Hills. I had previously made up a little gadget to check case wall thickness with (see photos #1-2-3). The spud is stepped so that a short case like a BR, or a longer case like a .308 can be checked. The brass was run over a Sinclair thirty caliber expander to get all the mouths and necks round. It seems as if the bulk brass is especially bad for out-of-round mouths. The 250 cases were all checked for wall thickness runout. Out of this bunch about 25 cases turned out to be .001 or less. Some 20 cases came with a reading of .002 to .003. Approximately 90 cases checked in with a reading between .003 and .004. The remainder of the brass was .004 or bigger. I decided to use the .003 to .004 brass for this test. The .002 and better brass would be saved for the 40X-BR project that would be coming up shortly.

After the thick side of the brass was established a small notch was filed in the rim to designate the thick side. This was done so that if needed the brass could be oriented in the chamber when the time came. With the case mouths already made round there is no need to chamfer before necking down or reforming. With a very little amount of case lube on the brass, it is run through the number one form die. This die just pushes the shoulder back to approximately where the BR shoulder will be (photo #4). The brass is still thirty caliber, a long necked 30 BR. At this point a preliminary trim is made. The brass is trimmed to about 1.600 or 1.700 inches in length. This is done so that the long neck does not have to be put through all of the operations yet to come. It's just a lot easier to make the next few modifications with a shorter neck rather than a long one.

The next step in the case forming process is an idea that I stole from Layne Simpson. He recommends that at this point you run a 30 caliber reamer into the case mouth. This accomplishes a couple of things. One, it takes some of the taper out of the case mouth that was brought on when the body of the case was formed into the new neck. The second thing that it accomplishes is make the shoulder of the 22, 6MM or 7MM/BR case thinner. Because the shoulder angle of all the BR cases are the same, when you take the 30 BR brass, which is what we have now, and neck it down to a smaller caliber, part of the 30 BR neck becomes part of the 22, 6 MM or 7 MM/BR shoulder. Layne's idea is that part of the accuracy problems people have with the BRs is that the brass in the shoulder is too thick. He says by thinning this area down a little bit the area of the shoulder neck junction the BR won't give as many problems. One of these problems is that the bolt can get hard to close after a few firings. This is fact; I know. A lot of you folks know this too. After a few firings the bolt can get to the point it just won't either open or close. Layne says the thick brass at the shoulder neck junction gets work hardened from the pounding of the high pressures. It loses its spring back, and as the case grows a little in length, soon you can't close the bolt. I agree with what he says about the hard closing bolt. If you been having problems with your BR you might try this step. At least reread his article on the subject. PS July 1986.

One other thing. The hard closing bolt problem that some folks have with the 22 and 6MM BR's seems to be less with the 7 BR. I have experienced the tough bolt problem with my 22 and both 6 BR's.

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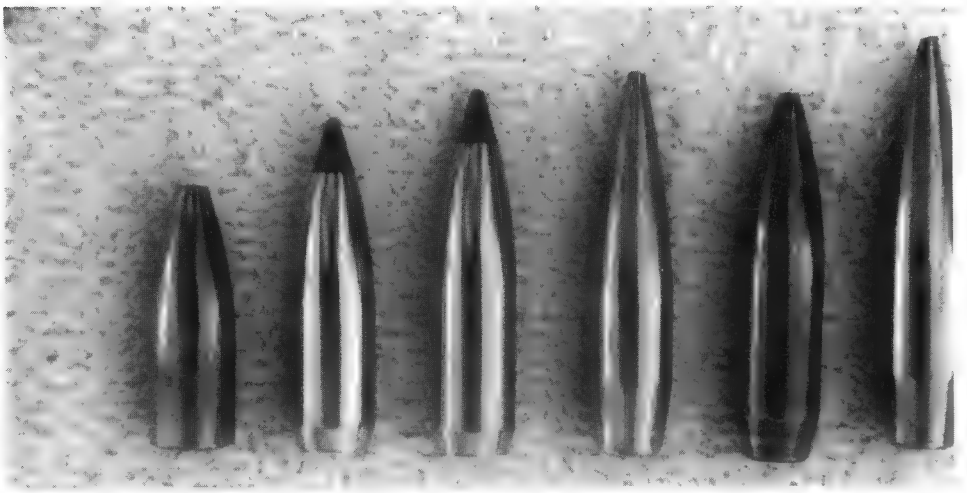
THE 7BR REMINGTON

Continued



L-R: Sierra 100 HP, Nosler 120 BT, Nosler 140 BT, Wall 140 VLD, Sierra 150 Match, Wall 155 VLD.

With the 7 BR's that I've dealt with, including the 7 BR rifle, the problem seems to be less noticeable. It could be because the surface area of the shoulder on the 7 millimeter is less than what the 22 and 6 MM are. If you put a 22 and a 7 BR case side by side it's easy to see that the 22 has about twice as much area in the shoulder as what the 7 BR case does.

Layne never said so directly but I got the impression he thought that this little trick would help the accuracy somewhat. When Seely Masker built my bench gun for me he chambered it for his 6 MM/SM Wasp. I had him make me up a couple of extra barrels; one in 22 BR, and one in 6 BR. When I made up the brass for the 22 BR I made two sets. One set of brass was made from the 308 basic brass. The other set was made from 7 BR brass. The brass made from 308 brass was not made with Layne's extra step. I never could get that brass to shoot consistently well, not to mention the hard closing bolt problem. It would occasionally turn in a good group but nothing like what the reformed 7 BR brass did. The cases made from the 7 BR consistently turned in better groups than the 308 brass did. Mister Simpson advocated using the same method when using factory 7 BR brass. Just neck it up to thirty caliber and ream it then neck it back down. I haven't tried this yet in the 22 BR but I can not see why a person couldn't get a little more consistency yet with it out of the 22 and 6 BR or even the 7 BR.

The actual numbers for the above operation are as follows. The number one form die that I have happens to be a RCBS. Redding makes one also. After the brass has been through this die it is trimmed to about 1.600 or 1.700 as mentioned. Pushing the shoulder back leaves a lot of taper on the inside of the neck. A standard Foster 30 caliber reamer is .308 in diameter or you could say it cuts a .308 hole. If this reamer is run into the case mouth it only takes just a tiny bit of material out right at the shoulder neck junction. By using a Forester .311 reamer instead, just about the right amount of brass is removed from inside the neck. The reamer does not start to cut until it is about a sixteenth of an inch inside the case mouth. At the shoulder neck junction the reamer takes about a .005 to .006 cut. In other words, starting from about a sixteenth of an inch inside of the case neck with a zero cut we progress to about a .006 inch cut at the shoulder neck junction. That gives you some idea of how much taper there is inside the case neck.

The next step is to run the brass through the number two form die, if you have one. If you do this you have to run the brass through the full length seater die before any more reaming or turning is done. The reason is that even though the second die makes the brass into 7 BR, it does not push the shoulder back as far as the full length sizer die does. If you ream or turn at this point when the case is full length sized you have an automatic "donut."

With the case now a 7 BR size there is one more little trick I do before going on. When the case is passed through the 7 BR die it is done so without an expander plug. Because of the thickness of the 308 case walls these 7 BR necks are quite thick, as we said. While the reaming at the 30 caliber stage removed a lot of the inside taper, it did not get quite all of it. At this point I ream the case once more with a .270 reamer. This reamer cuts a .277 hole. This just makes a light cut on the inside of the case neck. The brass sized down (Redding die) to 7 BR without the aid of an expander plug leaves the inside of the neck just a shade smaller than .277, about .276. This number includes the spring back. Actually, it's only part of the neck that is this size. The mouth of the case at this period in time has a diameter of about .278 to .279. The diameter of the inside of the neck at the shoulder neck junction is about .275 or .276.

This little ream job takes most of the last of the taper out of the case and also makes for a smooth surface for the neck turning mandrel. The case is next run over a 7 MM Sinclair mandrel. This brings the brass neck up to about .280 or .281, including the spring back. The mandrel is .283 and that is what it opens the case neck to, but the brass is thick and it springs back a couple of thousandths. There are a couple of ways around this. You can take a 30 caliber mandrel and turn it down to .285. You will end up with necks that are .283 after you run them over this mandrel. Then the 7 MM Sinclair mandrel (.283) will fit. Or, better yet you can take a second Sinclair 7 MM mandrel and turn it down to .281 at which point the mandrel will fit the brass after it has been over the .283 mandrel. This is an easier route to take because you only have to turn off a couple or three thousandths. At any rate, go back and reread Dick Wright's article on neck turning (November '93 issue of PS). It's one of the best I've seen on the subject. Dick is right, most people don't really understand just how to go about turning necks or what to look for. I have talked to a lot of people at matches who, when pressed about turning necks, just shrug their shoulders and say, "my gunsmith turned them for me." What fun is that? What's more, what did you learn by having someone else do it?

With this particular chamber I wanted a clearance of .0005 all around the neck. That's a total of .001, or .0005 per side. At first that's what the necks were turned to. Testing showed that after fire forming the new brass, the bullets were quite hard to seat. This was with no neck or full length sizing. They were just deprimed, reprimed and charged with powder. The boat tail bullets weren't too bad, but the flat base bullets would not seat without a lot of starting resistance. At first I was a little reluctant to turn any more material off the necks. The reason is that shooting pistol Silhouettes does not lend itself to reloading at the range very well. There is

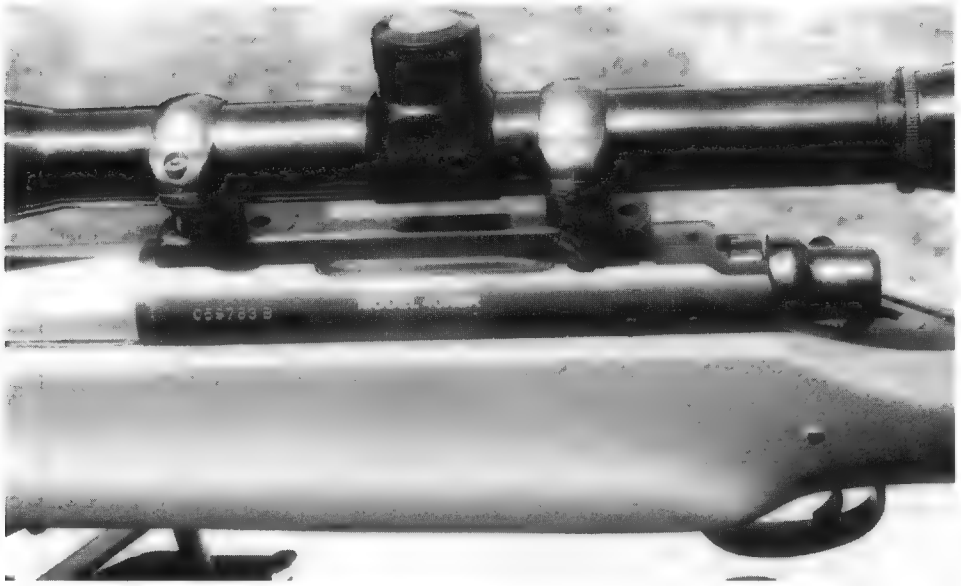


Photo #6.

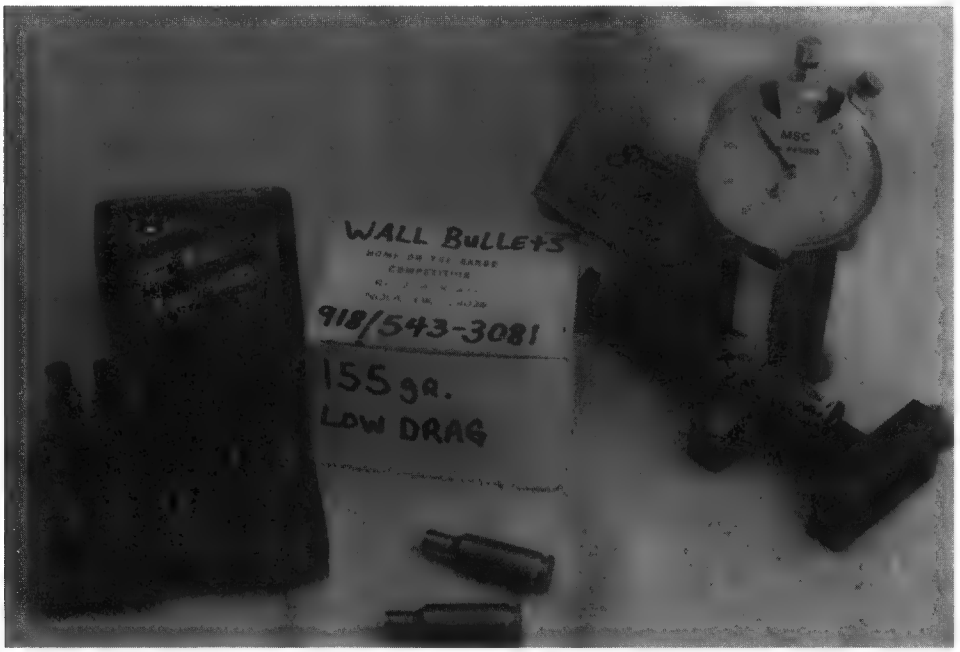


Photo #7.

just not enough time the way the matches are run. Therefore a person just about has to show up for a match with loaded ammo in hand. The point of all this is that if you're going to shoot a fitted or tight neck, then it has to be a tight enough fit so as to hold the bullets secure in the MTM box while you drive through the six jillon chuck holes that are on the entrance road to every known gun range in the Continental United States. I haul my loads around with the case head down, bullet up. If the neck tension is too light, all your carefully seated bullets will be sitting on top of the powder charge when you get there.

As mentioned above the bullets seemed a little hard to seat with only .001 clearance. I thought that maybe by turning the necks for a clearance of .001 all the way around (that's .002 total), the bullets might be a little easier to start. Not wanting to jump completely into the fire, I turned another .001 off (.0005 off each side) the necks of just five cases. This left me a full .001 clearance around the neck, .002 total. At this point the flat base bullet could be seated without damaging the bases provided that the case mouths were well chamfered. These five cases were tested several times to see if the group was effected any. To be honest it didn't seem like the groups changed very much one way or the other. After testing the five cases against the others I decided to turn the rest of them. In the end the gun ended up liking Nosler 140 grain Ballistic Tips, and Sierra 168 grain Match bullets. Both of these are boat tail design. With a good inside chamfer they both set okay in spite of the thick necks. The finished numbers on all the necks measures .310 with a bullet seated. The chamber is .312. The bullets are .284. What this comes down to is that the neck walls ended up being .013 thick, .026 total. That's a far cry from the .008 to .009 thickness found on a PPC. With necks as thick as these they don't move much.

Now that we had the necks thin enough to hold the bullets and still shoot well, I figured I'd take things a little further with five more cases. I took another full thousandth off the necks of five pieces. We now have a full .003 clearance. At this point the groups definitely began to open up a bit. Also the brass did not want to hold the bullets as tightly at this size. From here I could see no point in turning the necks any further. Apparently .001 all around (.002 total) clearance is what it takes in this particular gun for best accuracy. To make this test with the XP-100 a fair one I decided to test not only the fitted brass but some factory 7 BR brass as well. The factory brass with a bullet seated has an outside neck diameter of about .306 or .307. The factory brass did not group anywhere as good as my tight neck brass did.

The other thing that I tested was to try shortening the necks on the loads that were chosen for competition. Again I chose just five cases for this part of the test. I started out with about .004 clearance between the case mouth and the "mean little shoulder". Upon fireforming the brass the length decreased from about 1.538 to about 1.534 or 1.535. After a few firings they grow back to the 1.538 mark. This is where I keep them trimmed to. In any event the shorter I trimmed the necks the bigger the groups got. When they were trimmed down to about 1.500 the groups opened up what I thought was quite a bit, about an eighth of an inch at fifty yards on average. Anything down to about 1.520 did not alter the group size a great amount. Once the cases were shortened to less than about 1.510 the groups started to open up a little. At 1.490 the groups got real big.

I read with great interest Bob Jourdan's article in the November '93

Continued on next page

Photo #8.

issue of PS about the 25 BR. Bob made an interesting observation. He said that a 22 caliber bench gun needs about 32 grains of water to be accurate. He also said that the 6 MM needs about 34 grains of water. Moving up the scale that would put the 25 BR at about 35-36 grains of water. Using what Bob says as a guide that would put the 7 BR at about 38-39 grains of water. Most 7 BR brass will go about 38 to 40 grains of water, level full. This should put the factory 7 BR case right in the money for accuracy requirements. Bob never said if there was a barrel length requirement for this or not. It would seem to me on the surface of it at least, that a longer barrel might require a tad more case capacity. If what Bob says is true and I don't see why it wouldn't be, then with a good custom bullet there is no reason the 7 BR should not shoot.

All this fun with the 7 BR in various pistols plus what Bob said got me to thinking that I might like to have a rifle chambered in this cartridge just to see what it would do. There are not any commercial target rifles made in this caliber except the 40X-BR. I could of course have had a Bench Rest rifle built in this caliber. I don't have a Heavy Varmint gun. I could have had one built with a Talldog barrel. A second barrel could have been added in 7 BR just to fool with. Looking back on it that's probably what I should have done but at the time I decided not to. I have a 40X-BR chambered in 6 MM/BR. It is bedded in a Lee Six stock by Tom Meredith. Otherwise the gun is as issued. I really enjoy shooting the 6 BR. It will pretty consistently shoot in the high threes or low fours if I pay attention to what's going on with the wind flags. Not bench rest standards, but not bad for a factory rifle either. Just a fun toy to play with. I liked the 40 X so well that I decided to have one built in 7 BR. Going this route was cheaper, at least at first, than having a Heavy Varmint gun built by a Custom Gunsmith.

One of the things that had concerned me all along with this project was the recoil that a seven millimeter would generate. The actual recoil of the 7 BR in itself would not be that bad at all. But, the recoil might be a little much to try and shoot accurate groups off the bench. I'm aware that the Hunter Class bunch shoots 308's all the time. Some even shoot rather heavy bullets in them. I'm also aware that said 308's don't shoot groups like a PPC either. With a 7 BR there are no light weight custom bullets made that I'm aware of that I could shoot. Therefore I would have to shoot store bought bullets if I wanted to try some light weights. Reason would have it that a 100 grain bullet would thump you less than a 168 Match bullet would. I probably won't try any 168's just because they would make the gun move around too much.

Because of the recoil I ordered Remington's version of the Heavy Varmint, thirteen and a half pounds with a 24 inch barrel. After having put several rounds through the gun I have to say that I have been surprised. I think the recoil is very light, all things considered. One of the reasons for the light recoil could be the rather low velocity compared to the 6 MM. The weight of the rifle has something to do with it as well. On the other hand, one simply cannot shoot the rifle free recoil. The groups really open up! The gun just moves on the bags too much. It does require a firm, but not white knuckle hold.

Brass for this rifle was prepared exactly the same as what was done for the XP-100 pistol. As a matter of fact the chamber neck size is the same, .312. The necks were turned for .001 total clearance to start with in this 40X. I ran into the same problem all over again. The wall thickness is so great it makes it hard to seat the bullets. The saving grace here is that I can load at the range. I don't have to worry about transporting loaded rounds. Still, with neck walls that are .0135 to .014 thick, bullet seating can be a problem. It didn't take much testing to convince me that turning another .001 off the necks would make life a whole lot easier. I'm convinced that if a person had a 7 BR built with a .307 or .308 neck instead of a .312 neck, one could cut the neck with less clearance than the .002 that it seems to take just to get the bullets to seat without undo pressure. With a .308 neck one could end up with a loaded round that had a .307 diameter or maybe a little bigger. This way you would have neck walls that measured .008 rather than .012 or .013. Maybe some day we'll try that.

The rest of the drill was just about the same also. The overall length of the brass ended up being 1.535. This chamber is just a tad shorter than the XP-100 chamber (bolt face to the "mean little shoulder"). This one is 1.540 instead of 1.542 as the XP-100 is. I should point out that tests were run here also with regards to neck length. As with the XP-100, once the overall case length gets down to about 1.500 the groups really begin to grow. It seems to me that the longer you can keep the neck without actually touching "the mean little shoulder" the better the accuracy is, at least in some 7 BR's.

The pressure ring area of this rifle chamber is much bigger than what I'd like. The chamber measures .474 at this point. That's about .004 bigger than it should be in my estimation. Most of the 7 BR's I've encountered over the years measure about .470 at the pressure ring. This is a chamber measurement not a case measurement. This chamber is so big at this point I cannot get a fired case wouldn't go all the way in. The brass was just too big at the pressure ring. I tried a regular Redding seater die with the same result. The next step was to order a Wilson 7 BR die. Same deal here, the brass just wouldn't go in. Apparently most BR seater dies are made for brass that is about .472 in diameter at the rear

Photo #9.

or smaller. The three dies were all about this size. The fix here was to hone the rear of the Wilson die until the brass would enter freely. Everything worked out fine in the end, but it would seem that Remington made the rear of this chamber too big. I'm sure that a chamber this big is going to have an effect on accuracy.

As with the other BR's talked about here I took five cases and started turning the necks thinner. The first cut was for a full thousandth, clearance. The second cut, as mentioned was to take another thousandth off for a total of two (.002). This cut meant that we had .003 total neck clearance after the first two cuts. Immediately the groups opened up. No point in going any further here. In the past the reaction to thinning the necks has not been so much so fast. This could be tied to the large chamber. The tight neck may contribute to better bullet alignment in the throat.

Remington sent two factory targets with the rifle. One group measured .260. The second was .170. The target said a 150 grain bullet was used; didn't say what kind. The load was 27.0 grains of 3031, with a Remington seven and a half primer. It did not say what kind of cases were used for the proof test. One would assume factory 7 BR cases were used. The target further stated that the targets were shot off sand bags at 100 yards. One would further assume that the shooting was done indoors.....

The two targets were rather impressive. This certainly gave me something to work towards. It also looked like for a factory rifle it had the potential to group well. Testing the Sierra 150 grain Match bullet with IMR-3031 proved rather fruitless for me. I could not get it to work. It just wouldn't group consistently for me. One group would be in the two's and the very next one would go into the fours. Part of the problem is that IMR-3031 is really tough to get through the powder throw consistently. Perhaps if every powder charge was weighed things would have gone better. The bottom line with the IMR-3031 powder was that I didn't want to fool with it. Even though the factory obviously got it to shoot well, I wanted something that metered easily.

The smallest group that has been shot to date with the 40X-BR measured a mere .070. The bullet used was the very good Nosler 120 grain Ballistic Tip. I consider this group to be a fluke. Neither the gun nor I am capable of shooting in the zero's every time. However the gun will shoot in the high threes or low fours with this bullet if I work at it. All the 7 BR's that I've tested have shown a very great favoritism toward the Nosler 120, 140 and 150 grain Ballistic Tips. After testing these slugs in several different 7 BR's I would highly recommend the bullet in any weight.

There is a gentleman who lives in Oklahoma by the name of Ron Wall who makes a very good 7 MM custom bullet. Ron makes 168 and 180 grain VLD custom 7 MM bullets for the long range rifle shooter. He also makes the 155 grain VLD 7 MM. This is what first attracted me to Ron's bullets. I figured the 155's could be used to shoot in the 40X-BR as well as some of my Silhouette guns. The testing that I've done so far has shown that the 155 VLD's are very accurate. They have shown good promise in a couple of 7 MM handguns as well as in this 40X-BR. The very first group through the 40X with his 155 went right at .300. I consider this good for an old country boy who is by no means an expert off the bench and who hasn't got the wind flags figured out yet.

The deal with the 155 grain VLD's went

Continued on next page

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THE 7BR REMINGTON

Continued

so well I talked Ron into letting me try some of his 140 VLD's. Here again it looks like the man is putting together a good bullet. The first group with the 140 VLD's went just .270. Testing has shown that the gun will shoot these 140's almost as well as his 155's, provided the shooter works at it. I admit that the VLD's were not designed for shooting groups at 100 yards, but I wanted to try a custom bullet through the gun. I was not disappointed. Ron's bullets group very well considering the rifle is box stock. Ron can be reached at HOME ON THE RANGE COMPETITION, RT. 2, BOX 431 INOLA, OK 74036 (918) 543-3081.

Another good 7 MM bullet that I've had good luck with is Sierra's 150 grain Match. A look at the chart will show you that with the right load this bullet shoots pretty fair. Looks like there are three or four good bullets a fellow could choose from for accuracy work in a seven millimeter. When it gets right down to it if I had to choose it would be Ron's 155 VLD bullet. With 27.0 grains of AAC-2495 BR and the 155 grain VLD the 40X will shoot in the threes. I had started out with 29 rounds of converted brass. After culling out the ones that wouldn't group, tight necks etc., I ended up with twenty rounds of good brass. One day while I was getting ready to leave the range I decided to load up these twenty rounds and try four five shot groups with the aforementioned load. The first group went .330. The next was .410, then .350 and the last went .280. The way my math works that's an average in the threes.

A lot of folks that I've talked to about a powder choice for the BR's seem to like

40-XBBR data chart
by
Terry Wright

All data fired with 20 power scope
All data fired with Oheller 35 P chronograph
All data fired at 100 yards
All data fired with 308 basic brass reformed to 7 BR
All data fired with fitted neck. .312 chamber, .310 neck.

BULLET	POWDER	PRIMER	LOAD	FPS	ES	GROUP	COMMENTS
HOR	H-322	R-7.5	28.0	2523	70	.650	FLYIER
100	"	"	29.0	2620	46	.750	VIRTICIAL
HP	"	"	30.0	2685	25	.750	FLYIER
"	"	"	30.5	2703	36	.600	"
"	"	"	31.0	2785	53	.800	MAX
SIERRA	AAC-2015	R-7.5	28.0	2525	75	.400	
100	"	"	29.0	2658	93	.500	
HP	"	"	30.0	2668	48	.500	
NOSLER	AAC-2015	R-7.5	27.0	2422	48	.070	WOOOOOOOW !!!!!
120 BT	"	"	27.0	2402	34	.400	did not repete
"	A-322	R-7.5	27.0	2358	45	.500	
"	"	"	28.0	2464	45	.390	
"	"	"	28.0	2441	84	.500	
WALL	H-322	R-7.5	26.5	2286	17	.650	
140	"	"	27.0	2321	17	.270	WOW
VLD	"	"	27.0	2325	47	.500	
"	"	"	27.5	2359	8	.500	
"	"	"	28.0	2409	28	.450	.380
"	AAC-2015	R-7.5	26.0	2276	24	.600	
"	"	R-7.5	27.0	2337	35	.500	
"	"	F-205M	27.0	2368	46	.600	
"	"	"	27.5	2420	35	.400	good for 205
"	A-322	R-7.5	27.5	2367	38	.500	
"	"	"	28.0	2411	40	.500	
"	"	F-205M	28.0	2407	17	.500	
"	IMR-3031	R-7.5	27.0	2312	84	.490	
"	"	"	27.5	2335	48	.600	
"	"	"	28.0	2402	79	.800	
"	AAC-2495	F-205M	27.0	2249	26	.700	TOO LIGHT ?
"	"	F-205M	27.5	2302	16	.500	2.275 OVL
"	"	R-7.5	27.5	2279	35	.400	2.275 "
"	"	"	27.5	2275	16	.500	2.495 "
"	"	"	27.5	2284	77	.500	2.485 "
"	"	R-7.5	27.5	2278	27	.300	FLYER 2.465
"	"	"	27.5	2259	35	.800	2.465 OVL
"	"	F-205M	27.5	2287	32	.400	2.465 OVL
"	"	R-7.5	28.0	2266	30	.380	2.245 OVL
"	"	R-7.5	28.0	2308	25	.450	2.275 "
"	"	R-7.5	28.0	2305	55	.370	2.465 "
"	"	R-7.5	28.0	2288	19	.300	"
"	"	F-205M	28.0	2338	16	.600	"

W-748 a lot. They also said to use Federal 205 Match primers. I must be doing something wrong. I have had better luck with Remington's seven and a half's than Federal's 205. Neither can I get W-748 to work. Up until this point the powder choice has always been H-322 and AAC-2015 in my 7 BR's. I've tried a lot of other powders but I just can't get them to shoot. One would think that with case capacity like the BR that one could use a slower, bulkier powder. Like maybe AAC-2520 or H4895. It just doesn't seem to be. The slower powders will turn in an occasional good group, but not as consistently as AAC-2015, H-322 or even V-133 will. This is the first time that I've really got what I consider to be "slower" powder to work with this cartridge. I'm sure that the barrel length has something to do with it. AAC-2495 BR and the 155 VLD bullet really work well in this rifle. The combination will consistently turn in nice round groups. Darn good for a factory rifle that is being used just as it came out of the box. It says a lot for Remington's work and Ron's bullets.

Seating depth turned out to be a little different than what I had figured on. In the past the best accuracy shown to me with the 7 BR has been with bullets seated into the rifling. The same held true with this gun with factory bullets. The best groups were turned in with a definite mark on the ojive. With the 155 VLD bullets the best accuracy was obtained if the rifling just leaves a faint mark on the bullet. The overall cartridge length is 2.465. Actually the rifle will shoot just about as well with the bullet seated another .020 deeper, 2.445. Seating the bullet out to 2.485 makes the groups grow to four or fives.

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"	"	F-205M	28.0	2345	35	.600	2.465 OAL
"	"	R-7.5	28.0	2272	39	.500	Ron's 140 with
"	"	R-7.5	28.5	2343	46	.500	28.0 of 2495 BR
"	"	"	28.5	2358	87	.500	does very well
"	W-748	R-7.5	30.5	2318	36	.800	
"	"	"	31.5	2400	23	.700	
NOSLER	H-322						
140							
BT	AAC-2015	R-7.5	26.0	2307	20	.390	
"	"	F-205M	27.0	2379	39	.600	
"	"	R-7.5	26.0	2295	8	.280	
"	"	"	27.0	2407	43	.500	
"	AAC-2495	R-7.5	27.0	2186	134	.700	
"	"	"	28.0	2216	65	.600	
SIERRA	VN-133	R-7.5	23.0	2187	7	.600	
150 M	"	"	24.0	2246	31	.400	
"	"	"	24.5	2178	34	.600	
"	"	"	25.0	2249	18	.200	3 shot
"	"	"	25.0	2263	55	.750	5 shot
"	"	"	26.0	2322	40	.500	
"	H-322	R-7.5	25.5	2057	25	.600	
"	"	"	26.0	2126	7	.440	
"	"	"	26.0	2159	25	.440	
"	"	"	26.5	2163	31	.500	
"	"	"	27.0	2206	17	.400	
"	"	"	27.5	2334	16	.500	
"	AAC-2015	R-7.5	26.0	2220	30	.400	.600
"	"	"	26.0	2223	34	.360	
"	A-322	R-7.5	26.5	2232	35	.550	
"	"	"	26.5	2227	64	.450	shoots in the
"	"	"	27.0	2256	50	.400	fours.
"	"	"	27.0	2257	40	.450	
"	IMR-3031	R-7.5	24.0	1978	75	.390	
"	"	"	24.5	2044	62	.600	
"	"	"	25.0	2106	88	.800	
"	"	"	25.5	2143	45	.550	
"	"	"	26.0	2196	68	.470	.600
"	"	"	26.5	2226	71	.600	
"	VN-135	R-7.5	27.0	2178	46	.600	
"	"	"	28.0	2280	10	.550	
"	"	"	29.0	2358	16	.600	
Wall	H-322	R-7.5	26.0	2188	36	.300	great
155	"	"	26.5	2240	26	.425	
VLD	"	"	27.0	2300	26	.600	
"	"	"	27.5	2334	29	.470	
"	"	"	28.0	2377	22	.800	HOT
"	A-322	R-7.5	27.5	2315	31	.600	
"	"	"	28.0	2379	34	.450	too hot ????
"	AAC-2495	R-7.5	27.0	2205	54	.330	.375 2.465 OVL
"	"	"	27.0	2194	30	.290	.400 "

No representation as to the safety of these loads in other rifles is made by either the writer or the publication.

MATERIAL. LOADS HERE AND METHODS WERE SAFE IN MY GUN; THEY MAY NOT BE SO IN YOUR GUN.

It looks like I have found the dimensions needed to make a factory 7 BR shoot with a factory chamber. It seems that the factory chamber wants about .002 total neck clearance. .002 produces a lot of bullet pull with necks that are .013 to .014 thick. This seems to be okay. Most 6 MM's that I've dealt with seem to like less bullet pull than the 7 BR does. Cutting the brass length so that it is within .005 to .010 of bumping the "mean little shoulder" seems to help the accuracy in these factory chambers. I'm convinced that because of the generosity the factory shows with their chambers one could do better with a smaller (thinner) neck. Remington makes their chambers big to cover every contingency; they have to. Still, if one had a 7 BR with a .307 or .308 neck then the wall thickness in the necks could be thinner. With thinner necks one could cut the brass for a tighter clearance. We could then operate in the realm of where the true target rifle operates. I think .013 or .014 is just too thick to get the best accuracy potential out of the rifle.

Now, if I could just get Seely to build a heavy varmint with an extra barrel in 7 BR....., with a tight neck....., a short throat to fit Ron's 140 grain VLD's..... then...

Terry Wright
31770 Fayetteville Dr.
Stedd, Oregon 97377

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ACCURACY TUNING

(Dan Hackett)

Dear Dave,

I am a relative newcomer to the sport of High power competition (which is why I subscribe — my interest in shooting not my 'newcomer' status) and have been intrigued to read of loads for the 'Thunderstick 7000' which contain 215.694 grs of Blasto 5432 behind a 678 gr barge-tailed, hand-waxed, titanium tipped, uranium coated Cyclops.

Now I am sure you detect my exaggeration which is offered as a lighthearted introduction to a serious question, which is: why are some loads expressed in seeming arch precision of power load? Why 44.8 gr. of Mulwex 2208 rather than 45.0? Allow me to share some thoughts on this, the better that you understand *my* knowledge, or lack thereof, so that you can answer my questions.

1. Loading to attain a specified pressure is reasonable (in the strict meaning of the word) but does not assure accuracy, nor is it easily done at home, and anyway the laboratory conditions would be difficult for the handloader to replicate.

2. Loading to attain a specified MV is reasonable, can be done under actual field conditions with individual (vice lab.) rifles, but one's intuition that this is the answer is refuted by the lack of such an objective in the many handbooks, and in any event is not the criterion of accuracy.

3. Shot to shot consistency is what might be sought, which suggests a load to fill the case (to what datum?), but here surely 0.2gr. would not make a difference. Perhaps the loader estimated a volume quantity using the Mk. I eyeball and only after selecting this load did he weigh it so as to duplicate it later, and so we get 44.8gr. The difficulty with this hypothesis is that the human urge to simplify would have it be 44.5 or 45.0gr (or is the Bureaucratic urge to obfuscate and complicate stronger?).

4. With some insight into ballistics it could be argued that the ideal load is that which *consistently* has the bullet depart the muzzle at the same point in the cycle of barrel flex, that is at the same angle of departure for each shot, but how is this to be measured?

5. The use of such precise loads (44.8 not 44.7) suggests that there is a difference between the two such that one is preferred over the other. How is the different *result* identified and measured? Furthermore, the use of such loads suggests that small differences in power load (or burning rate) do matter. If so then how does a shooter go about finding out what this difference is and how to take advantage of the information in his own loads?

6. Most shooters seem to prefer their own specific load, rather than a group handout as in Palma, and this suggests that different rifles prefer loads unique to them, but if this is the case how is that load determined? By trial and error? If so what endpoint is used?

7. It has been asserted in more than one article in those publications marketed for the hoi-poloi (as distinct from serious journals of gentlemanly past-times) that any reasonable load should prove adequately accurate in a properly set-up rifle, so why the interest in differences of one tenth of a grain of powder? There is no obvious advantage of a MV of 2600 over, say, 2644, provided each shot was consistent with the others.

You can see my quandary. Different 'official' publications give different figures for supposedly comparable loads (and some are *very* different: Speer N° 11, p 217/308/165gr/BLC2 42.0=2612fps; Hodgdon 1992, Oct. p. 14/308/168-172gr/BLC2 46.0=2614 fps) though barrel length could be argued as the cause of this difference (22" in Speer, 26" in Hod.) This counterargument fails however with 180gr bullets and H414; Speer•50.0=2554fps; Hod•47.0=2553 fps. Of interest is the observation that these two official sources cite powder weights in whole grains for most loads, and where fractions are recommended that fraction is 0.5.

Once more unto the breech: why the 44.8 rather than 44.7 or 45.0? Why was the Palma ammo made this way as it was not for use in one specific rifle? What was the end-point sought by this load?

I am trying to 'work up' a load, or rather a set of loads for use in competition, but do not know how *best* to do this. Should I experiment with decimal-fraction loads? How do I determine which is best? At present I can test at a local range; some loads give me 2MOA groups and occasionally 1MOA, and even at times 1/2MOA. I can reasonably consistently get 1-1/2MOA with one specific load but want to improve on that performance, but do not know how much can be gotten by fiddling with loads. One result of my experiments has me baffled: some loads group 2MOA one inch to the right of the point of aim, and others 2MOA 1 inch to the left, while my best load to date (1-1/2 MOA) is centered. I believe these data eliminate shooter error as the cause. Elevation variance as a consequence of different loads I understand, but not lateral.

I do understand that the most important technical component of any shooting is the nut behind the butt-plate, and am interested in why some loads are in decimal fractions of a grain, or, more precisely, what is the determining factor(s) in deciding the end-point sought, and how is this best done by a shooter who does not have access to sophisticated ballistic measurement equipment.

I do hope one of your many fine consulting specialists will have the time and patience to ponder this issue and offer an opinion.

Sincerest Best Wishes
and many Thanks,
Yours Sincerely,
Anthony J. Adolph

DAN HACKETT REPLY

Dear Anthony,

Answering the most basic of your very interesting questions first, I suspect the reason for the Palma load being 44.8 grains of AL 2208 (aka Hodgdon Varget) instead of 44.7 or 45 grains is a simple one: Australia and New Zealand use the metric system.

44.8 grains is equal to 2.9 grams, a nice, clean two-digit measurement. 45 grains works out to a messy four digits (2.916) in gram measurement, and I'd bet the team that developed the Palma ammo didn't worry about increments measured in milligrams.

There are a few other reasons why we see reported charge weights that don't fall on the full- or half-grain mark:

1. Most reloading manuals report whatever velocity the testers obtained with a charge of a certain size. But a few, such as the Sierra and Hornady books, report whatever charge size they found necessary to reach a certain exact velocity, to the nearest tenth of grain. This latter method usually results in scale readings that don't terminate in .0 or .5.

2. Some powder measures, like the Culver which is so popular with benchrest shooters, are adjustable in fixed increments that don't usually coincide with full- and half-grain measurements.
3. Many shooters fine tune their loads during development to achieve specific accuracy goals, and work with small changes in charge weight as part of that effort. This can result in wasted time and components when tiny charge increments are employed at the wrong point during development, but sometimes it pays dividends in improved accuracy. In my opinion, that possibility makes this last of the three reasons the most interesting and pertinent to the questions in your letter.

As you point out, many articles in popular publications have stated that a good rifle should shoot well with any reasonable load. In fact, I have published such statements myself, and will do so again. But statements that good accuracy does not depend on finding one particular weight of one particular powder should always be understood with three caveats in mind. First, its truth depends on having that good rifle. If there is something wrong with your gun's bedding, barrel or the alignment of action parts, it is much more likely to be very picky about powder charges, if it will ever shoot well at all with any load. If you are serious about accuracy, you owe it to yourself to have a qualified specialist go over your rifle and take care of any problems you can't find and fix yourself.

Second, top accuracy requires best-quality ammunition. Good bullets must be seated straight and concentrically at a depth that works with one's barrel, in cartridge cases that promote uniform ignition and burning of powder charges. (This is an area I suspect you'll find productive to investigate, and to which we'll return later.)

Third, obtaining good accuracy doesn't rule out the possibility of making it even better. I can get half-minute groups — certainly adequate for most purposes — with most of my rifles and just about any suitable powder by paying attention to bullet seating depth and to cartridge uniformity and alignment. But does that mean I can't get even tighter groups by playing with the powder charge? It does not.

Consistently shooting super-small groups depends very strongly on finding a load which works with a barrel's vibration characteristics to keep the muzzle as still as possible during bullet exit. Judging from recent experiments I've conducted with barrel tuners such as the BOSS, the amount by which muzzle vibration changes with small variations in charge weight is disproportionately large. Increasing or decreasing the charge by only one or two tenths of a grain — an amount too small to make a meaningful difference in the ballistic performance of a cartridge like the .308 Winchester — is enough to throw off a BOSS rifle that was perfectly tuned to the old charge weight. The effect in a non-BOSS barrel has to be similar, but you don't have the option of moving the weight a few thousandths of an inch to compensate for it. You can only alter your charges a small amount at a time and see what if any effect it has on your average group size.

(Incidentally, it is this matter of changing barrel vibrations which explains the lateral shift in point of impact you've observed with some changes in load, and the size of the shift is an indication of how much your barrel changes its vibration pattern. Barrels vibrate in all directions, and it is not unusual to see rifles show horizontal impact shifts as yours does. Note that this may be symptomatic of a bedding or barrel problem, or of misalignment between barrel, receiver and bolt that causes the barrel to whip sideways when these parts are subjected to firing pressure. Again, it would pay you to have your rifle checked by a competent accuracy gunsmith, if you have not already done so.)

Returning to the topic of ammunition quality I mentioned a few paragraphs back, I don't see anything in your letter to indicate you are working with any ammo variable other than charge weight. Your efforts would be much more immediately productive if applied elsewhere.

Assuming you are loading good bullets — *absolutely* vital to accuracy — the next things you should be paying attention to are the position of your bullets relative to the throat (seating depth, in other words), and the alignment of those bullets to your barrel bore.

Seating depth can make more difference in group size than many shooters are prepared to believe. A load that shoots bugholes with bullets seated 0.010" into the lands might produce groups measuring an inch or more when the bullets jump 0.010" before reaching the lands...or vice versa. Experimenting with different seating depths should be conducted very early in load development, before you start a lot of tinkering with powder type and charge weight. The seating depth which works with a given barrel tends to be constant; find what gives the smallest groups with one load, and it will probably be best with all others. You do need an accurate seating depth gauge for best results, but such a tool is cheap compared to the benefits it offers.

Another important factor in accuracy is proper bullet alignment with the bore. A bullet which enters the barrel off center or cocked at an angle will not straighten out. It will be deformed by the forces acting on it and will not fly true. As long as your chamber is lined up with the bore — something you can't take for granted, unfortunately — you can obtain substantial improvements in accuracy by paying attention to the alignment and concentricity of your loaded cartridges. Basically, the closer the exact center of bullet and cartridge case come to being on the same straight line, the better your ammo will shoot. You can measure bullet runout (the amount of offset from cartridge-case centerline) with the concentricity gauges offered by several manufacturers of reloading tools. Excessive total runout (and anything over 0.003" is way too much) can be corrected once you know where it is being introduced in the reloading process. Sometimes it is necessary to replace a sizing die or bullet seater with a more precise unit, or you may have to switch to using different brass. It is often possible to significantly reduce bullet runout by using neck-turned cases.

It is fashionable among some writers in

Continued on next page

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Cleaning Brass Economically

by

Paul Inskeep

I have a unique formula for cleaning cartridge cases that was given to me by Mr. M.D. Waite, while he was in charge of the National Rifle Association's Reloading Section. This formula is simple, economical, and safe for the environment. It is so simple and economical I am sure every one will want to try it. I have used this formula for more than twenty years and have continued to be satisfied by its results. It leaves the brass cases with a polished shine.

I deprime my cases before cleaning. This is best done using a punch and deprimer sold by Wilson Tools. Depriming the cases is not necessary but I think it does a better job with the old primer removed. It is amazing how long the old primer will retain moisture and keep the pocket damp, requiring individual drying upon priming.

The ingredients are listed below:

PLASTIC JUGS	2 (1 gallon)
WHITE VINEGAR	1 gallon
SALT	1 teaspoon
SOAP POWDER	1 tablespoon
WARM WATER	FROM TAP

Now to get on with how to do this. First we fill one **plastic jug** half way with the **white vinegar**. Then we add **1 teaspoon of salt** and **1 tablespoon of soap powder**. Depending on which caliber of cartridge cases you're cleaning, the amount of cases to be cleaned at one time varies. Usually twice as many pistol cases as rifle cases (as a rough rule of thumb) works well.

To the mixture we have just put together we add the cartridge cases and then **hot water from the tap**. The hot water works the soap powder and vinegar. Now **seal** the **jug** with the lid and **shake vigorously** for about **one minute** or so. Pour the liquid contents into the other jug, **for reuse**. Fill the jug containing the brass cases with warm water from the tap and shake for about one more minute. Pour this liquid down the drain and rinse cases and set them on end to dry. Set them open end down. They will dry over night, or on a warm sunny day I set them in the sun and they dry quickly. Your cases will have a **natural look**, not the brassy look some cleaners leave on them.

The mixture can be used over and over. You will know when it has lost its effectiveness by how cloudy the water gets. I have an old coffee pot, which, long ago, my wife tried to throw away, that I use to reheat the mixture for the second session, and so on.

I hope you try this simple, long proven, and effective way to clean your cases. It can handle even the dirtiest cases! It doesn't take long, it is economical, and it is, most importantly, safe around the house.

Paul Inskeep
1911 Robinwood Road
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ACCURACY TUNING

Continued

the popular firearms press to badmouth "benchrest" case-preparation techniques, including neck turning, as unnecessary or ineffective. On the other hand, everyone I know who obtains consistently superior accuracy with a variety of rifles and calibers puts the majority of reloading effort into case preparation. The reason for this discrepancy, I think, is that the guys and gals shooting the really tight groups are careful to use case prepping as part of a well-coordinated effort to improve cartridge alignment and consistency rather than applying it randomly in the hope it might fix something or other without their knowing exactly what and how. It does no good, for example, to turn the necks of cases that are curved along their length, or to make primer pockets and flash holes uniform, then seat primers at randomly varying depths or load badly balanced, misshapen bullets, but people have given up on case preparation after doing just this sort of thing.

The reason I'm going into all this is, the group sizes you report are bigger than you should expect with a match rifle, and I doubt you will see a major improvement just tinkering with your powder charges. I would strongly suggest you buy or borrow a concentricity gauge and case neck micrometer and make some careful measurements of your cartridge cases and loaded rounds. Your results will either tell you what is wrong with your cartridges, or they will tell you your ammo is OK and your rifle needs attention. Either way, you'll be in a better position to correct your rifle's accuracy.

At this point this letter has probably gone on longer than you expected to endure when you wrote to *Precision Shooting*, and has only indirectly answered many of your questions while going off in directions you didn't ask about at all. Sorry about that, and I will certainly endeavor to provide specific answers to more of your questions in another letter if that is your desire, but what I have tried to do is provide information that I believe will help you get your rifle shooting better rather than concentrate strictly on powder charge weight. I hope it is of use to you.

Sincerely,
Dan Hackett
Precision Shooting

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IS A SLING MORE ACCURATE THAN BAGS?

by

Dave Scott

Do some rifles shoot more accurately in the grasp of prone shooters than resting on sandbags? This perplexing issue has recently been raised in these pages by Dave Milosevich, Merrill Martin and Paul Nordquist.

I was first confronted by the alleged superiority of sling over sandbag nearly 30 years ago when a friend told me he could shoot his Remington Model 722 in .222 Rem. better on dirt than from a bench. Just when I was confident I'd heard every wild claim ever uttered along a firing line, this was a new one. In a classic case of shortsightedness, I dismissed the remark, concluding that Ernie was an excellent prone shot but not so handy on a stool. After all, how could anyone **not** shoot better from rock-steady sandbags?

A few weeks later we met at a local range to sight in our varmint rifles for a crow hunt. I arrived with a back-breaking .22/250 built around a Model 70 action and 26", straight-taper Douglas barrel. All this steel was additionally held down in brisk winds by a massive Herter's laminated stock with a fairly wide, flat forend and a 12X Unertl Ultra-Varmint scope. Friends, this rig should have had an axle instead of sling hardware.

Calling upon years of benchrest prowess, I smugly sat down at a bench and punched out a vertical group measuring .930" for 5 shots at 100 yards. Apparently tickled pink with the sighting and accuracy level, I was putting things away when Ern asked to shoot the ponderous rifle.

Smiling tolerantly, I handed him the .22/250 and some ammo and watched unimpressed as he snapped his sling into the studs and plopped on the ground. He managed to catch my attention, however, when he quickly popped off five shots in .496". Trying to conceal my embarrassment, I challenged him to do it again. He put another five rounds in .730". By the way, I'm not relying on memory for these dimensions. I'm looking at that accursed target even as I slave over this hot computer.

Since then I've listened quite attentively to prone shooters I've deviously led into discussions of sling versus bags. Seems that accomplished ground shooters are as comfortable hinting at the superiority of their technique as reporting UFO sightings. I can understand their reluctance. That many rifles shoot poorly on sandbags seems to defy reason. But does it?

I'm not sure many of us have a proper appreciation for the rifle movements that can occur between the time the trigger releases and the bullet departs the barrel. I certainly didn't until a dozen years ago, when I began to suspect that the motion of the firing pin mechanism, combined with barrel time, can be fully as devastating to the accuracy of centerfires not specialized for riding bags as to rimfires. I now believe it takes an incredibly consistent and practiced bench technique to coax good accuracy from most rifles, especially those with the slim, woefully ineffective forends so many shooters seem to admire or at least accept. And even then, the prone position may produce better accuracy from these same guns.

What accounts for the ability of accomplished prone shooters to produce a higher degree of accuracy from some rifles? We'd have to assume it's partly due to the benefits of pulling a rifle firmly and straight back into the shoulder. This likely creates a recoil pattern that's more consistent than that of the same rifle perched on sandbags, given that steady crosshairs tend to lull a bench shooter into sloppiness in holding the rifle identically from shot to shot, if indeed the shooter has developed any bench technique at all. In addition to the prone shooter's body providing greater, more consistent resistance to the rifle's movements, the sling and hands additionally arrest vibrations and the motions of recoil. Too, because the position is somewhat unsteady, the prone shooter tends to bear down and follow through on each shot just to compensate for the built-in shortcomings of unsteady sights.

Questions have been posed whether rimfire BR-50 rifles may shoot better from the prone position than the bench. Because these rimfires are specially designed for bench use, this leads to another piece of the puzzle I find most fascinating of all. I suspect that the **hardness** of sandbags, in itself, stirs up all kinds of problems in many rifles, be they rimfire or centerfire. The problem seems most evident in rifles with lengthy barrel time or heavy recoil. If this is true, the softness or "give" of the prone shooter's support at both the forend and butt would be a major contributor to the prone position's characteristic accuracy.

The reason I suspect that the hard, unyielding support of sandbags may harm accuracy stems from a bizarre incident that occurred well over a decade ago. I had just purchased a new Feinwerkbau 124 air rifle in .17 caliber and a 3-7X Beeman scope with adjustable focus. In this field-style air gun, a stout spring drives a piston forward to propel a light pellet at moderately high velocities.

Since I had been wanting to shoot my Heavy Varmint Class 6PPC, I toted both rifles to the range. After firing the 6PPC, I worked the 124 down into those rock-steady sandbags and began firing at a target I'd set up at 25 yards. I was stunned to see that expensive air gun shooting all over the target. Actually, that's not quite accurate; it often missed the target altogether. Shot after horrid shot, I watched in dismay as my plans of picking off sparrows and starlings on my birdhouse crumbled. Thunderation, this rifle couldn't hit a bull in the butt!

Because the manual indicated these air rifles shot more accurately after a break-in period, I began to cycle quick shots through it to hasten the process. Shooting with no rear bag and with the forend hurriedly cradled in my hand which rested on the front pedestal, instantly the groups shrank to tiny dimensions.

Months and thousands of shots later, I had settled on the most accurate way of holding this incredibly sensitive rifle. The technique amounted to pulling the stock straight back into my shoulder with consistent pressure and no sandbag support at the rear. The forend rested on foam rubber held in my fingers, with the back of my hand supported on a sandbag. In hunting, I carried the foam afield.

Even the Feinwerkbau 300-S match air rifle I currently shoot is sensitive to a hard support. Although the barreled action of this .17 cal. slides backwards on short rails to counteract the forward motion of the piston and spring, the gun shoots best with the same setup as the 124, except the forend is not so sensitive and can simply be gripped with the fingers.

Browsing through an air rifle publica-

tion, I saw a photo of a 300-S being accuracy tested at the maker's factory in Germany. I noted with great interest that the rifle wasn't perched on sandbags, but was steadied on a rest resembling a partially filled medicine ball. Suspicions confirmed.

What do BB guns have to do with **real** rifles, you're asking. Well, taking a long, hard look at the Model 124 air rifle, what we have here is basically the equivalent of a low-velocity firearm cursed with a slow-moving, one-pound firing pin. Indeed, 16 ounces is approximately the weight of the piston and heavy mainspring. When you combine the relatively low velocity of an air gun with the horrendous effects of all this steel lunging forward a few inches, what you have is the most exaggerated, prolonged, magnified example of barrel time you're likely to encounter. Therefore, any influencing factors, such as the shooter's hold on the rifle and the effects of rifle support, stand out starkly and can be easily observed. Clearly, both the 124 and 300-S don't like hard rests, and if their performance is harmed by firm sandbags, it seems likely that firearms also may suffer from the same malady.

By now, a promising concept has crossed our collective minds. Being that our trusty sandbags don't provide a soft rest, would the same outcome be achieved instead by a stock that's nicely flexible, maybe even mushy? After all, the barreled action wouldn't know whether the cushioning resulted from the support or from the stock. Wouldn't a rifle with a noodle for a stock shoot like blue blazes?

I wouldn't bet on it. The benefits to accuracy of stiff, unyielding stocks have been widely recognized in the competition benchrest community. A few years ago it was all the rage to slap the flat bottom of a benchrest stock forend. If it slammed against the barrel, you were seen as being in possession of defective equipment. In 1983 Tony Boyer set a new IBS record. For this he gave a goodly amount of credit to his stock made of cherry wood fitted with an aluminum bedding block. "This stock is really stiff," Tony reported in the November, 1983 issue of *Precision Shooting*. "I believe this has helped my shooting in Light Varmint..."

In 1988 Steve Chernicky authored a *PS* article in which he asserted that the larger the movement of the stock during the firing cycle, the more bullet dispersion at the target. He added that at the Cactus Classic benchrest event he had the opportunity to check the stock flex of a number of good-shooting rifles, and all of them were extremely firm if not almost rock hard, especially in the 13-1/2 pound class.

Finally, we should be keenly aware that Houston Warehouse shooter and driven experimenter Virgil King used conventional benchrest stocks resting on a pedestal bag filled with a Portland cement/casting sand mixture and a rear bag using only casting sand to achieve steel-like hardness. Moreover, he emphasized the necessity for the front bag to be positioned roughly midway between the front of the action and the tip of the forend. He pointed out that if the forend is supported farther toward the tip, accuracy deteriorates due to increased stock springiness. Questioning the equipment and technique contributing to Virgil's uninterrupted strings of zero-level groups with his Light Varmint Class 22PPC and other superb rifles doesn't appear constructive.

There's a considerable difference, however, between extremely specialized benchrest rifles and guns for hunting and other types of target work. Have tests been conducted to truly confirm that when it comes to stocks, stiff is best for all rifles—centerfire and rimfire, competition and hunting, barrel-bedded and free floating? Or have many of us simply gone along in a demonstration of the monkey-see, monkey-do syndrome? I confess I was stampeded into the rigidity school of thought years ago, and it prompted me into fiberglassing strips of aluminum reinforcement along the barrel channels of some of my stocks, even though the forends were already stiff. While I did not carefully compare these stocks before and after modification, I can only **suspect** that the stiffened forends are to some degree responsible for the fine accuracy of these custom rifles.

In an attempt to get to the bottom of these searing questions, after my air rifle revelations I attached a strip of foam carpet backing to my front pedestal bag in a brief test with both my benchrest rifle and some hunting guns. If there were any improvements in accuracy, I don't recall it, meaning there surely weren't. However, I've made a note to do more experimentation.

If I haven't obtained finer accuracy by softening the front rest, I do believe that softening the rear bag has been beneficial to my hunting rifles and perhaps my benchrest gun. What I attempt to do at the bench is duplicate some of the features of the prone position. With my elbows resting on the bench, I concentrate on pulling the stock straight back, firmly into my shoulder. I want the crosshairs to start out well above the target so I can squeeze a plain, conventional sandbag (not a rabbit-ear type) on target. All sighting corrections are made by manipulating the bag with my free hand. The sole purpose of the trigger arm (besides squeezing the trigger) is to pull the rifle firmly and straight back into my shoulder. While this technique is generally reserved for my hunting rifles, I recently did some target math on my Light Varmint Class 6PPC. Over a period of months, a considerable number of groups shot this way averaged a little smaller than those fired free-recoil.

If indeed this technique improves the performance of a rifle, I suspect an essential part of the equation is starting each time with the crosshairs far above the bull's eye and then squeezing the rear bag to bring the rifle on target. This **softens** the bag, perhaps to some degree simulating the give of the prone shooter's hold.

Although this method is not quite as steady as pressing a rifle into sandbags, for many rifles the holding technique is far more important than small sighting errors. Otherwise, every gun would shoot its very best on sandbags. And sports fans, we need only listen to what the sling shots have been telling us for years to know that just doesn't happen.

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THE EXTERIOR BALLISTICS OF OLD AND MODERN TWENTY-TWO CALIBER VARMINT BULLETS

by

Robert L. McCoy

Twenty-two caliber centerfire varmint rifles have been in use in the United States for about a century. In his book, *Twenty-Two Caliber Varmint Rifles*, published at the end of the Second World War, Charles S. Landis states that such pioneering gunsmiths and rifle cranks as Dr. Franklin W. Mann, E. A. Leopold, Harvey A. Donaldson and Reuben Harwood were conducting experiments during the mid-1890's with jacketed .22 caliber bullets and smokeless propellants. Not much information exists today on the exact shapes and dimensions of these early jacketed bullets. According to Landis' comments, some of these bullets were round nose designs; others had pointed or semi-pointed ogival nose shapes.

By the time *Twenty-Two Caliber Varmint Rifles* was published, the two most popular commercial brands of .22 caliber varmint bullets were the Sisk bullets, made by R. B. Sisk of Iowa Park, Texas, and the Wotkyns-Morse 8S bullets, most of which were made by Charles B. Morse of Herkimer, New York. The Sisk bullets were tangent ogive designs, with ogive radius between 5 and 6 calibers, and had relatively small nose tip bluntness. The Wotkyns-Morse bullets were secant ogive designs. The "8S" designation implies an 8 caliber secant radius; however, my recent measurements show the actual secant ogive radii of the Wotkyns-Morse bullets vary between 11.0 and 12.4 calibers. Both the Sisk and the Wotkyns-Morse .22 caliber bullets were flat base designs; boattailed varmint bullets had not yet arrived on the scene in the mid-1940's.

Varmint shooters of the 1940's were considerably less technologically inclined than are modern riflemen. Chronographs were non-existent, except in U.S. Government ballistic laboratories, and in the laboratories of the largest commercial ammunition manufacturers. There were few, if any, published ballistic coefficients for the .22 caliber varmint bullets on the market at that time. Varmint shooters of that era simply loaded the available bullets into their cartridge cases, went out to the rifle range, and shot them. They learned where to hold at various distances by shooting at various distances, not by running a PC with exterior ballistics software! The author's varmint shooting career started in the early 1950's, and from personal recollection, the situation was still the same at that time.

An opportunity recently arose to compare the exterior ballistic characteristics of several .22 caliber varmint bullets produced in the mid-to-late 1940's with those of modern varmint bullet designs, made by the Hornady, Sierra, and Speer bullet companies. The author's friend and colleague, Gene L. Harwood, of St. Helens, Oregon, contacted Mr. Allen Bench, of Kennewick, Washington, and obtained samples of .22 caliber Sisk, Wotkyns-Morse 8S, and early production Hornady and Speer bullets. Gene kept some of these bullets for his own collection, and sent several of each type to the author for ballistic evaluation.

There are two accurate methods for determining the ballistic coefficients and gyroscopic stability factors of rifle bullets. The best method is free flight testing in an instrumented ballistic firing range. However, this method is time consuming, expensive, and requires a significant number of each type of bullet for the testing. The second method, which requires only a small sample of bullets, is to use a Mann comparator to make the required bullet contour measurements, and modern aeroprediction computer programs to estimate the aerodynamic drag and gyroscopic stability. Computer programs such as "MCDRAG," written by the author in 1974, and "MCGYRO," also written by the author in 1979 and revised in 1986, provide estimates of the drag coefficient and the gyroscopic stability factor that are accurate to within +/- 5 percent error at supersonic speeds. Since only a few of the older bullets were available for measurement, the second method was used for ballistic evaluation of all the bullets considered for this article.

Ogive contour measurements were done on samples of both the new and old .22 caliber varmint bullets, using a Mann optical comparator, and the ogive coordinates obtained for each bullet were fitted with the arc of a circle, using the method of nonlinear least squares. This technique determines the "best fit" circular arc, ogive radius, nose length and meplat (nose tip flat) diameter for each bullet. Figure 1 is a photograph of a sample of the old and new .22 caliber varmint bullets. The results of the Mann comparator measurements are summarized in Tables 1 and 2.

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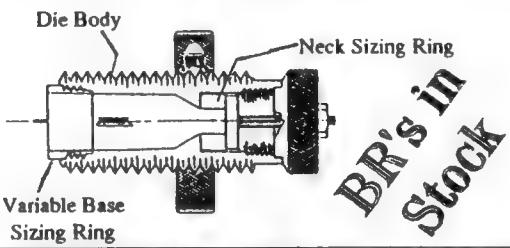

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Table 1					
Modern .22 Caliber Varmint Bullets					
Bullet	Total Length (Calibers)	Nose Length (Calibers)	Ogive Radius (Calibers)	Noseshape Parameter R_T/R	Meplat Diameter (Calibers)
Hornady 45 Gr. Hornet	2.69	1.65	10.18	0.46	0.30
Hornady 50 Gr. SXSP	2.93	1.61	8.91	0.49	0.29
Sierra 50 Gr. BLITZ	2.97	2.00	7.02	0.81	0.24
Sierra 55 Gr. Spitzer	3.27	2.20	5.95	1.00	0.16
Speer 50 Gr. TNT	3.02	2.04	8.79	0.72	0.28

Table 2					
1940's Vintage .22 Caliber Varmint Bullets					
Bullet	Total Length (Calibers)	Nose Length (Calibers)	Ogive Radius (Calibers)	Noseshape Parameter R_T/R	Meplat Diameter (Calibers)
Sisk 40 Gr. Express SP	2.50	1.74	5.12	0.75	0.14
Sisk 41 Gr. Super Lovell	2.55	1.71	5.71	0.69	0.15
Sisk 50 Gr. Lovell SP	2.93	1.92	5.30	0.90	0.16
Sisk 55 Gr. Express SP	3.12	2.02	5.22	1.00	0.17
Wotkyns-Morse 45 Gr.	2.81	1.69	12.38	0.33	0.18
Wotkyns-Morse 47 Gr.	2.85	1.68	11.07	0.39	0.22
Wotkyns-Morse 50 Gr.	3.03	1.75	11.73	0.36	0.20
Hornady 45 Gr. Hornet	2.56	1.30	- - -	0	0.39
Speer 4 Cal. Ogive 50 Gr.	2.85	1.78	4.03	1.00	0.16

The noseshape parameter (R_T/R) in the above tables is probably an unfamiliar term to most riflemen, and therefore needs some explanation. The actual ogive radius of the bullet is denoted by the letter R. If a tangent ogive radius were constructed for the same bullet, e.g., the same nose length and meplat diameter, the length of that tangent radius would be R_T. The noseshape parameter is the ratio of the tangent radius R_T to the actual radius R. A conical (pencil-point) nose may be thought of as an infinite radius (with zero curvature); therefore a conical nose has an R_T/R value of zero. If the nose shape actually is a tangent ogive, then R equals R_T, and R_T/R then has the value one. For any secant ogive, R is greater than R_T, and the noseshape parameter R_T/R then takes on some value greater than zero, but less than one. The effect of the noseshape parameter on aerodynamic drag will be discussed presently.

The "MCDRAG" computer program was run for all the above .22 caliber bullets, and the drag coefficients obtained were divided by the industry-standard G_1 drag coefficients at the same velocities (actually, at the same Mach Numbers). The resulting form factors relative to G_1 were then averaged over the useful velocity range, from 3500 fps (feet per second) down to 1800 fps, which roughly corresponds to target distances out to 400 yards. The sectional densities were divided by the form factors to compute average ballistic coefficients, relative to the G_1 drag function, for all the .224" diameter bullets. Note that the tabulated ballistic coefficients correspond to sea-level, standard atmospheric conditions of 29.53 inches Hg barometric pressure, 59 degrees Fahrenheit temperature, 78% relative humidity, 0.0751 pounds per cubic foot air density, and 1120.27 feet per second speed of sound in air. The "MCDRAG" predicted form factors and ballistic coefficients are listed in Tables 3 and 4.

Continued on next page

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THE EXTERIOR BALLISTICS OF OLD AND MODERN TWENTY-TWO CALIBER VARMINT BULLETS

Continued

Table 3

Modern .22 Caliber Varmint Bullets

Bullet	Sectional Density	"MCDRAG" Form Factor	Ballistic Coefficient
Hornady's 45 Gr. Hornet	.128	.692	.185
Hornady 50 Gr. SXSP	.142	.693	.205
Sierra 50 Gr. BLITZ	.142	.620	.229
Sierra 55 Gr. Spitzer	.157	.584	.269
Speer 50 Gr. TNT	.142	.628	.226

Table 4

1940's Vintage .22 Caliber Varmint Bullets

Bullet	Sectional Density	"MCDRAG" Form Factor	Ballistic Coefficient
Sisk 40 Gr. Express SP	.114	.630	.181
Sisk 41 Gr. Super Lovell SP	.117	.629	.186
Sisk 50 Gr. Lovell SP	.142	.612	.232
Sisk 55 Gr. Express SP	.157	.618	.254
Wotkyns-Morse 8S 45 Gr. SP	.128	.627	.204
Wotkyns-Morse 8S 47 Gr. SP	.134	.641	.209
Wotkyns-Morse 8S 50 Gr. SP	.142	.617	.230
Hornady 45 Gr. Hornet SP	.128	.901	.142
Speer 4 Cal. Ogive 50 Gr. SP	.142	.667	.213

Modern manufacturers of commercial jacketed bullets all publish the ballistic coefficients of their bullets, relative to the G_1 drag function, in their respective reloading manuals. Comparison of the "MCDRAG" predicted ballistic coefficients for modern .22 caliber varmint bullets with the corresponding values published by the bullet companies shows generally good agreement.

For example, "MCDRAG" predicts ballistic coefficients of .185 and .205 pounds per square inch, respectively, for the Hornady 45 grain Hornet and 50 grain SXSP bullets. The 4th Edition of Hornady's reloading manual lists the ballistic coefficients of these bullets as .202 and .214. Hornady's value is 9 percent higher than the "MCDRAG" value for the 45 grain Hornet bullet, and 4 percent higher for the 50 grain SXSP bullet.

The "MCDRAG" values of C for the Sierra 50 grain BLITZ and 55 grain Spitzers are .229 and .269, respectively. The 2nd Edition of Sierra's reloading manual lists three values for the BLITZ bullet, at three different velocities, ranging from 3300 fps down to 1700 fps. Taking an average of Sierra's ballistic coefficients, we find the mean value to be .235 pounds per square inch. Sierra's value for their 55 grain Spitzer is .276. In both cases, Sierra's values are approximately 3 percent higher than the corresponding "MCDRAG" values.

"MCDRAG" predicts a ballistic coefficient of .226 pounds per square inch for the Speer 50 grain TNT bullet. The new Speer Number 12 reloading manual lists a value of .223, for the same bullet. The Speer ballistic coefficient is 1 percent lower than the "MCDRAG" value.

Inspection of the values in Tables 3 and 4 shows that, in general, the heavier bullets have the highest ballistic coefficients, as expected. However, if we compare the results for a fixed bullet weight, say 50 grains, some of the ballistic coefficient trends appear to defy the "conventional wisdom". For example, secant ogive noseshapes, such as the Hornady and the Wotkyns-Morse 8S bullets, are generally considered to be lower drag shapes than tangent ogive noses, such as the Sierra or Sisk designs. The data in Tables 3 and 4 show that the ballistic coefficients of the 50 grain secant ogive bullets are no higher than those of tangent ogives of the same weight, and in fact, can be significantly lower! In order to understand what is happening here, we must go back to "first principles," and look at the general effects of bullet dimensions on aerodynamic drag.

Figure 2 shows three bullet sketches, with the pertinent dimensions illustrated. The nose length, in calibers, is denoted by L_N. The actual ogive radius is denoted by R, in calibers, and the tangent radius is R_T, also in calibers. The ratio R_T/R is the noseshape parameter discussed previously. Finally, the diameter of the nose-tip flat, which ballisticians call the "meplat diameter," is denoted by d_m, in calibers.

Figure 2(a) illustrates a bullet with a conical (pencil-point) nose shape. This ogive has absolutely no curvature, and the noseshape parameter is therefore zero. Figure 2(b) is a sketch of a secant

.22 Caliber Bullets (L. to R.) Sisk 40 Grain Express SP; Sisk 41 Grain Super Lovell SP; Sisk 55 Grain Express SP; Wotkyns-Morse 8S 45 Grain SP; Wotkyns-Morse 8S 47 Grain SP; Hornady 50 Grain SXSP; Sierra 50 Grain BLITZ; Speer 50 Grain TNT; Old Hornady 45 Grain Hornet Spire Point; Modern Hornady 45 Grain Hornet; Old Speer 4-Caliber Ogive 50 Grain SP; Speer 50 Grain TNT.

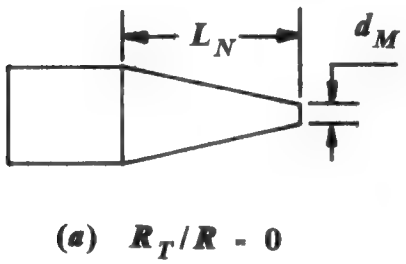
Figure 1. Photograph of Some Old and Modern .22 Caliber Varmint Bullets.

ogive nose shape, whose generating ogive radius, R, is greater than the value of R_T for the same nose length and meplat diameter. The curvature of the secant ogive in Figure 2(b) is less than that of the corresponding tangent ogive, and the noseshape parameter falls somewhere between the values zero and one, depending on the actual value of R.

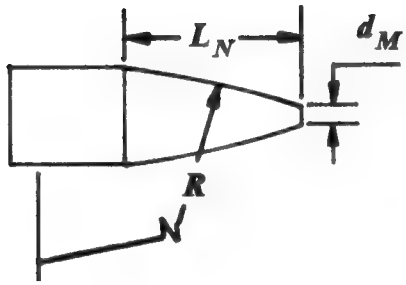
Figure 2(c) illustrates a true tangent ogive nose shape, whose actual radius R equals R_T/R and the noseshape parameter, R_T/R is therefore equal to one for any tangent ogive nose.

All the dimensional quantities illustrated in Figure 2 have an effect on the aerodynamic drag, and therefore on the bullet form factor. We will look at the effect of

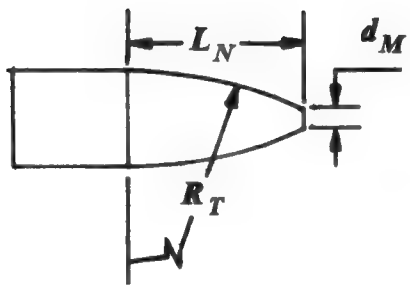
Continued on next page



(a) R_T/R - 0



(b) $0 < R_T/R < 1$



(c) R_T/R - 1

Figure 2. Bullet Sketches Showing Different Nose Shapes

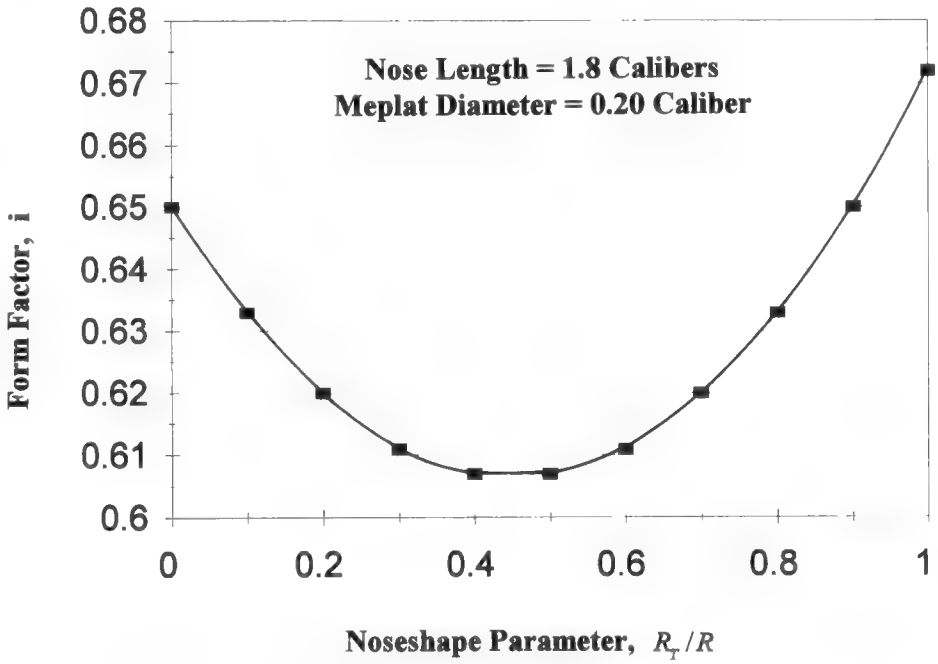


Figure 3. The Effect of Noseshape on the Form Factor

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THE EXTERIOR BALLISTICS OF OLD AND MODERN TWENTY-TWO CALIBER VARMINT BULLETS

Continued

several systematic variations of nose shape, nose length, and meplat diameter on the form factors of typical .22 caliber varmint bullets at supersonic velocities.

For a fixed nose length of 1.8 calibers, and a fixed meplat diameter of 0.20 caliber, Figure 3 shows the effect of the noseshape parameter, R_T/R, on the form factor, i (relative to G_1), at supersonic speeds. The curve of Figure 3 was generated by the "MCDRAG" computer program, which accurately reflects the results of experimental measurements made in the Free Flight Aerodynamics Range of the U.S. Army's Ballistic Research Laboratory at Aberdeen Proving Ground, Maryland. Note the parabolic shape of the curve in Figure 3. The tangent ogive nose shape (R_T/R = 1) is the highest drag (highest form factor) shape. The conical (pencil-point) shape (R_T/R = 0) is a lower drag shape than the tangent ogive, but the minimum drag shapes are secant ogive noses, whose R_T/R values lie in the range 0.4 to 0.5. This means the lowest drag bullet nose shapes will always be secant ogives, whose actual ogive radii are between 2 and 2.5 times the corresponding tangent ogive radius for the same nose length and meplat diameter. The "conventional wisdom" is correct; secant ogives are indeed the lowest drag shapes at supersonic speeds. Note that the form factor of a tangent ogive nose shape is approximately 11 percent higher than that of a minimum drag secant ogive nose, for a fixed nose length and meplat diameter.

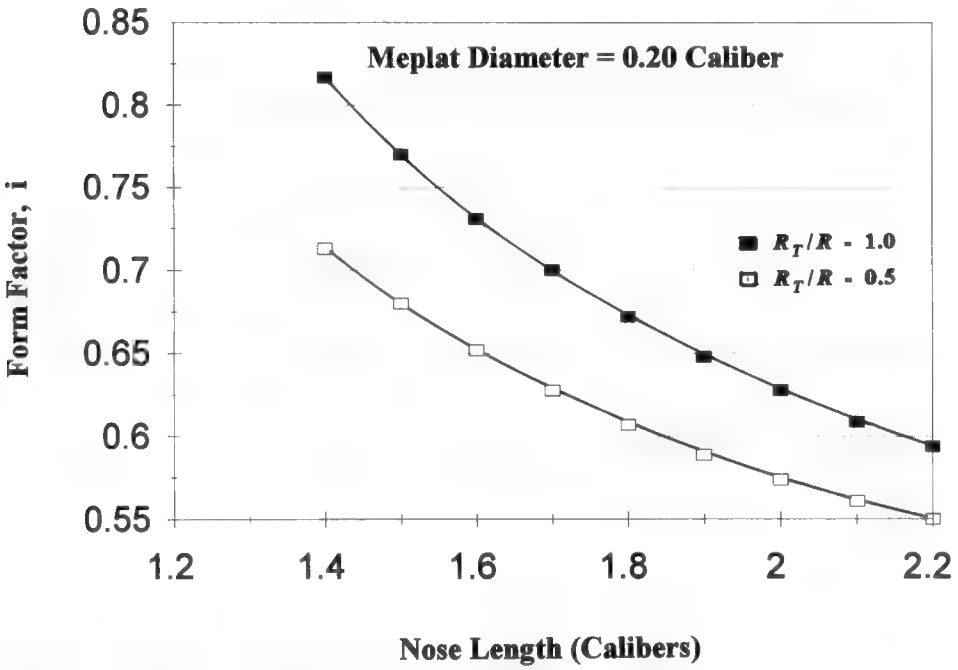

Figure 4. The Effect of Nose Length on the Form Factor

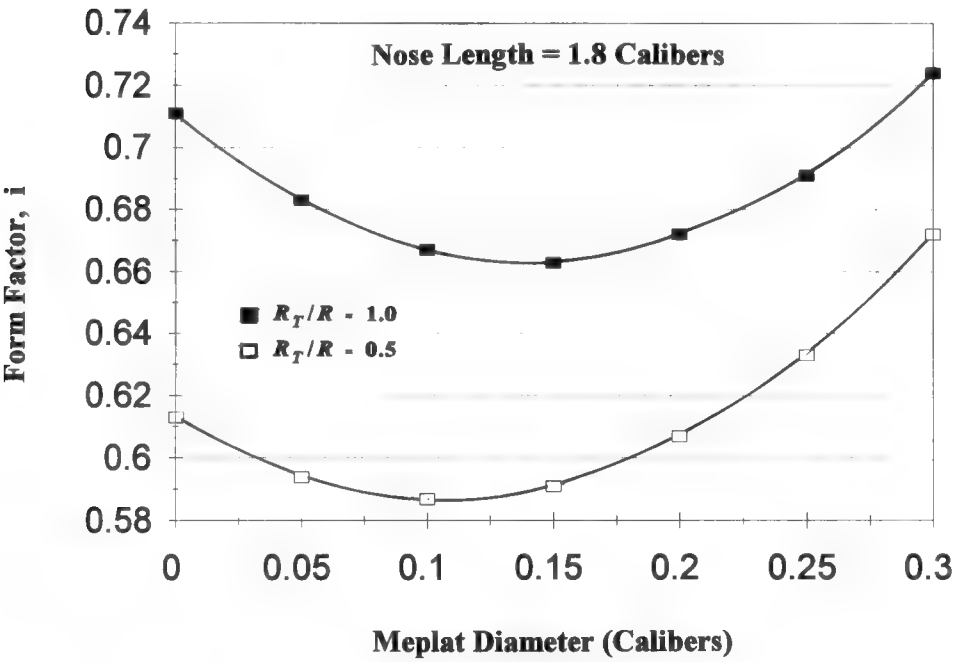

Figure 5. The Effect of Meplat Diameter on the Form Factor

The effect of varying the bullet nose *length* at supersonic speeds is illustrated in Figure 4, for a fixed meplat diameter of 0.20 caliber, and for two values of the noseshape parameter. Since the tangent ogive (R_T/R = 1) nose shape has the highest drag, and the secant ogive whose R_T/R= 0.5 has the lowest drag, the form factor of any other nose shape will lie between the two curves plotted in Figure 4. Note that increasing the nose length from 1.4 calibers to 2.2 calibers decreases the drag by more than 30 percent! Increasing the nose length by only 0.2 caliber decreases the average form factor by approximately 7 percent.

The effect of varying the meplat diameter is shown in Figure 5, for a fixed nose length of 1.8 calibers, and for both tangent ogive and minimum drag secant ogive nose shapes. Note that a sharp pointed nose does not give the least drag! Minimum drag at supersonic speeds occurs for meplat diameters between 0.10 and 0.15 caliber, depending on the nose length and the particular value of the noseshape parameter. The aerodynamic explanation for this effect is rather complicated. Increasing the meplat diameter increases the flat frontal nose area subjected to the very high Rayleigh stagnation pressure. At the same time, increasing the meplat diameter decreases the average slope along the ogive, which reduces the wave drag on the ogive itself. There is a trade-off between these two effects, which gives rise to the curves illustrated in Figure 5. Note that increasing the meplat diameter

from the minimum drag value of 0.10 to 0.15 caliber up to 0.30 caliber, increases the form factor by approximately 12 percent.

The trends shown in Figures 3 through 5 may now be used to help interpret the ballistic coefficient results listed in Tables 3 and 4. As a first example, consider the 50 grain Hornady SXSP and the Sierra BLITZ designs of Table 3. The form factor of the Hornady bullet is .693, compared with .620 for the Sierra BLITZ, which means the Hornady bullet has about 12 percent more drag. Turning to Table 1, we see that the Hornady SXSP bullet has a minimum drag noseshape parameter of 0.49, compared with the value 0.81 for the Sierra BLITZ design. This translates to about 6 percent less drag for the Hornady bullet. However, note that the Hornady nose length is nearly 0.4 caliber shorter than the Sierra's L_N, which means approximately 14 percent *more* drag for the Hornady SXSP. Finally, we note that the Hornady bullet has a larger meplat diameter than the Sierra BLITZ; the difference is 0.05 caliber, which translates to about 4 percent more drag for the Hornady bullet. Adding up the three contributions gives:

(-6% + 14% + 4%) = +12% more drag for the Hornady bullet

A similar comparison of the 50 grain Sisk and Wotkyns-Morse 8S bullets, using the values in Tables 4 and 2, shows that the noseshape difference predicts about 7 percent less drag for the Wotkyns-Morse bullet. However, the shorter nose *length* gives approximately 6 percent more drag for the Wotkyns-Morse design, and its larger meplat diameter contributes about 2 percent additional drag. The total adds up to +1 percent more drag for the Wotkyns-Morse 8S 50 grain bullet, in agreement with the form factors shown in Table 4.

Modern varmint shooters and riflemen who have personal computers, and any of several commercially available exterior ballistic software packages, can use the results presented in Table 4, to run trajectories for typical .22 caliber varmint bullets that were on the market in the 1940's. Comparison trajectories may also be run for modern bullets, using either the ballistic coefficients published in current reloading manuals, or the values listed in Table 3.

A final comment on the results of Tables 3 and 4 is that the difference in exterior ballistic performance between .22 caliber varmint bullets made 50 years ago and those currently on the market, is not as large as one might expect. There may well be significant differences in *accuracy*. Modern .22 caliber bullets will probably shoot smaller groups than those made in the 1940's, but that has more to do with better quality control on jacket wall thickness, precision core forming, etc., than it does on bullet *design or shape*.

Turning now to the gyroscopic stability, the "MCGYRO" computer program was also run for both the new and the old .22 caliber varmint bullets. Muzzle velocities of 3000 fps and 3500 fps were selected, and rifling twist rates of 14 inches per turn and 16 inches per turn were considered. The differences in stability factors between 3000 fps and 3500 fps turned out to be negligible (of order of 0.02), so the results were averaged and are tabulated against twist rate only. Note that the gyroscopic stability factors correspond to the same sea-level, standard atmospheric conditions referenced in our earlier discussion of ballistic coefficients. Tables 5 and 6 list the gyroscopic stability values for new and old .22 caliber varmint bullets, respectively.

Table 5

Modern .22 Caliber Varmint Bullets

Bullet	Rifling Twist Rate (Inches/Turn)	Gyroscopic Stability Factor S_g
Hornady 45 Gr. Hornet	14	1.9
Hornady 45 Gr. Hornet	16	1.4
Hornady 50 Gr. SXSP	14	1.5
Hornady 50 Gr. SXSP	16	1.1
Sierra 50 Gr. BLITZ	14	1.5
Sierra 50 Gr. BLITZ	16	1.1
Sierra 55 Gr. Spitzer	14	1.2
Sierra 55 Gr. Spitzer	16	0.9
Speer 50 Gr. TNT	14	1.5
Speer 50 Gr. TNT	16	1.2

Continued on next page

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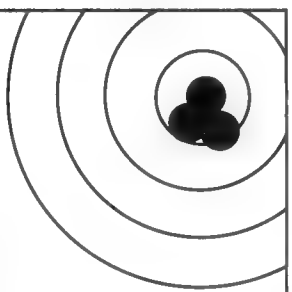

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THE EXTERIOR BALLISTICS OF OLD AND MODERN TWENTY-TWO CALIBER VARMINT BULLETS

Continued

Table 6

1940's Vintage .22 Caliber Varmint Bullets

Bullet	Rifling Twist Rate (Inches/Turn)	Gyroscopic Stability Factor S_g
Sisk 40 Gr. Express SP	14	2.2
Sisk 40 Gr. Express SP	16	1.7
Sisk 41 Gr. Super Lovell SP	14	2.1
Sisk 41 Gr. Super Lovell SP	16	1.6
Sisk 50 Gr. Lovell SP	14	1.5
Sisk 50 Gr. Lovell SP	16	1.1
Sisk 55 Gr. Express SP	14	1.3
Sisk 55 Gr. Express SP	16	1.0
Wotkyns-Morse 8S 45 Gr. SP	14	1.8
Wotkyns-Morse 8S 45 Gr. SP	16	1.4
Wotkyns-Morse 8S 47 Gr. SP	14	1.7
Wotkyns-Morse 8S 47 Gr. SP	16	1.3
Wotkyns-Morse 8S 50 Gr. SP	14	1.5
Wotkyns-Morse 8S 50 Gr. SP	16	1.2
Hornady 45 Gr. Hornet SP	14	2.2
Hornady 45 Gr. Hornet SP	16	1.7
Speer 4 Cal. Ogive 50 Gr. SP	14	1.6
Speer 4 Cal. Ogive 50 Gr. SP	16	1.2

Most modern riflemen know that the gyroscopic stability factor must be greater than 1.0, if the bullet is to be stabilized in flight. But how much greater should it be? That depends on several factors. First, the requirement for dynamically stable flight (which is a bit too complicated for this article), requires that S_g not only be greater than 1.0; it must also be greater than a particular value, stated in terms of the dynamic stability factor. For the relatively short, flat based bullets discussed in this article, a reasonable value for this minimum S_g is about 1.2. Second, a safety factor is usually required to allow for cold weather (high air density) firing. If there is a possibility of shooting in temperatures down to zero degrees Fahrenheit, at sea-level altitude, the average air density will run about 13 percent higher than at standard atmospheric conditions. This translates to about 1.4, as a minimum sea-level standard-conditions gyroscopic stability factor, for cold weather shooting. On the other hand, if you always shoot near Albuquerque, New Mexico (4960 feet altitude), the average air density will be 86 percent of sea-level standard, and you could probably get away with a sea-level S_g of 1.0 for shooting at such high altitudes.

The gyroscopic stability results of Tables 5 and 6 show that all the .22 caliber varmint bullets weighing less than 50 grains are adequately stabilized by the 16" twist of rifling. The 55 grain bullets are unstable, or borderline unstable from a 16" twist; they require a 14" twist for adequate gyroscopic stability. The 50 grain designs show stability factors in the borderline 1.1 to 1.2 range from a 16" twist, and a 14" twist is therefore recommended for 50 grain bullets.

Tables 5 and 6 also show that the gyroscopic stability factor is less sensitive than the ballistic coefficient to variations in bullet nose length, nose shape, and meplat diameter. At supersonic speeds, the gyroscopic stability depends more on the bullet weight and total length, and, of course, the rifling twist rate.

In summary, the results of Mann optical comparator measurements, combined with modern aeroprediction computer programs, have recently been used to establish the exterior ballistic performance of several .22 caliber varmint bullets that were commercially available in the 1940's. Similar estimates were also made for several modern .22 caliber varmint bullets, to provide a basis for comparison with the older designs. This project has been both interesting and enjoyable to the author, and it is hoped that today's varmint shooters will find the results informative and useful. Good luck and good shooting!

About the Author

The author, an exterior ballistician and consultant, resides with his wife and daughters near Stewartstown, Pennsylvania. McCoy served for 36 years as a ballistician with the U.S. Army, retiring in 1994. He spent 30 years with the Ballistic Research Laboratory (BRL) at Aberdeen Proving Ground, Maryland, where he conducted both theoretical aerodynamic studies, and many experimental firings in the BRL spark photography ranges. McCoy has a master of Science degree in Aerospace Engineering from the University of Notre Dame, and is the author of more than 40 technical publications on the aeroballistics and flight dynamics of small arms bullets, medium caliber cannon projectiles, and large cannon artillery shell.

THE REVIVAL OF AN OLD SHOOTER

by

Ron Boccard

A great deal of thought went into the title for this article. First, there is the word "old" stuck in there. That is no coincidence. In the bit of history that follows, you (the reader) will become aware of the fact that I have been around for more than just a little while. The word "revival" seemed appropriate, I thought about using the word "resurrection" but that might have been just a little too presumptive. The fact is that after a span of about twenty non-shooting years, I have again taken up the musket and begun to compete with myself and others.

But first, let's review a little ancient history so as to put this story into perspective. I started competitive shooting in High School. I don't mean while I was of High School age, I mean in High School. Imagine that! Guns in school, guns in a New York City High School. Something that today would be just about unthinkable.

It was just after World War II had ended, and a few of us "kids" found pictures of the school rifle team in some old (pre-war) year books. We begged and pleaded until we got a teacher to agree to sponsor the rifle team activity at the school. There was a 50 foot range in the basement of the building and low and behold the teacher found four or five old Savage model 19's tucked away in a locker somewhere. That was the start of what was to become (four years later) the PSAL (Public School Athletic League) champions, and winners of the William Randolph Hearst Trophy for shooting.

Of course we quickly progressed to better rifles and equipment. We shot four positions (prone, sitting, kneeling, and standing) and scores averaged in the mid to high 180's with metallic sights. During those years I was shooting a Winchester model 75 and looking to improve my shooting performance. It was well into my third year in High School that I made the "deal of a lifetime".

During that period the names that were synonymous with competitive rifle shooting were Art Cook and Art Jackson. Art Cook had won a gold medal at the Olympics and had become a hero to many of us who aspired to higher levels of competitive shooting. Well, through word of mouth, I became aware that Art Jackson had one of Cook's rifles and wanted to sell it. I bought that Winchester model 52-B for $65.00. It took a lot to convince my parents that the price was not highway robbery and that it would be worth it in the long run. It sure was. My shooting improved, the team scores improved, and in the end I was rewarded with an athletic scholarship to St. Johns College. Now that's not something you hear of very often these days. A college that sponsors a rifle team to the extent of providing scholarships for its members.

The college years seemed to coincide with an elevated level of gallery shooting (indoor position shooting at 50 feet) in the New York, New Jersey, and Connecticut area. In fact there seemed to be an increase in this type of shooting all up and down the east coast. There were matches everywhere. League matches around town with other teams. There were tournaments in other cities where competition existed between teams and individuals. Matches were conducted in three and four position shooting with metallic sights and with scopes. Individuals would compete for high aggregate scores, teams would total the scores of the four or five shooters who made up the team. Sometimes the teams could be "pick-up teams" other tournaments would allow only "recognized" teams. The competition was FUN.

The league competition was fierce. I was a member of a team called "The Manhasset Musketeers". We would shoot on Thursday nights, at our home range, or away matches on which ever night the opposition team deemed as their choice.

Some of the people who were on those teams still stand out in my memory. Otto Kolb, (who shot for "Roslyn Rifle and Pistol Club") who managed to shoot highly competitive scores (usually well above the 194 mark) despite a serious physical handicap. Otto could not bend his legs and feet to assume the necessary kneeling position and therefore had obtained permission to fire the kneeling segment of the match from a standing position as well as completing the regular standing segment.

There were some memorable characters shooting on the "Musketeers" team also; Frank Briggs, who was to earn a reputation as both an individual shooter and as a coach and advisor to the US Olympic shooters at the Olympic training center in Colorado. Then of course there was Tom Kennedy. Tom was always one of the top contenders at our league matches. He invariably placed as one of the top five. He was not only good, but also consistent. Years later, while working in Europe, Tom saw a notice that there was an upcoming rifle match in Holland and decided it might be fun to enter. Thus Tom became the Dutch National Champion.

Some of the tournaments of the time were also somewhat unusual. There was the indoor 100 yard matches at the 14th Regiment Armory in Brooklyn. Imagine being able to shoot rim fire .22's at well lighted targets with an absolute minimum of wind. There were two matches, iron sight and scope, with an aggregate score for both. One of the consistent competitors at this match was a man who had been shooting competitively for over 50 years. I do not remember his first name, but Mr. Balestrieri was well into his 70's and still shooting. Not only still shooting, but winning with his Pope barreled Ballard action that had been modified to speed up the lock time.

Then there was the annual 200 yard indoor shoot at the Winchester test range in New Haven, Connecticut. There were a number of idiosyncrasies involved with this competition. The shooting was done from a prone position while laying on a wooden bench that had an unwanted tendency to rock back and forth. Next, the range itself extended from one building in the factory, through a tunnel under the street to another building. There were no lights in the tunnel itself, but the targets were brilliantly illuminated. The result was that after firing a shot one

Continued on next page

THE REVIVAL OF AN OLD SHOOTER

Continued

could actually watch the bullet as it entered the lighted space just before it struck the target. The time of flight for a .22 rim fire at 200 yards approaches 0.7 of a second and that gives the shooter plenty of time to transfer the eye from the center of the target to the upper left quadrant to see the bullet arc (hopefully) toward the center of the target. Another peculiar feature of this range was the "wind". If someone were to open the door to the range a blast of wind would roar through the tunnel with such velocity that you could swear a hurricane had entered the building.

Although some of these matches and tournaments were unusual and fun, it was the regular league matches and the three and four position tournaments that seemed to encourage the sport the most. It was in this field that the competition became the most intense. It was this intensity of competition that began to elevate the scores. No longer would the mid to high 180's even get you in the "top five" on a team at a league match. In order to place in the upper ten percent at a tournament your twenty shot score had to exceed 194 or 195 out of 200. Equipments were improving, ammo was improving. The European influence began to affect the design of the rifles. Thumb hole stocks began to appear, palm rests and hook butt plates became prevalent, Shooting jackets developed into leather straight jackets with a hundred buckle closings.

The competition became even more intense. Scores improved ever so slightly. It's tough to drag a score up by a full point or two when you're already shooting fifteen or so tens out of twenty shots, and remember that five of that twenty had to be done from a standing position. With all this pressure the competition was still FUN. A 195 at a league match and you felt good, a 198 in a tournament and you went home elated!

In case you might be wondering what happened to that Winchester model 52-B during this phase of my shooting pursuit, it was still there. Perhaps it changed the way it looked a few times, but it was always my primary competitive rifle. It went through glass bedding, free floating, and electric bedding. It went from the factory stock to a custom stock that fit my body dimensions more accurately, and finally into an international free rifle stock that not only fit me but brought the total weight up to 15 pounds, without sights. It was employed to shoot at 50 feet indoors, 50 and 100 yards outdoors, and at 50 Meters in international matches. All together, over a period of about 20 years, there had to be well over 150,000 rounds fired through that barrel and it still shoots well, only once did the rifle cause me any problem and that was because the headspace had become excessive.

> (A note to those of you out there who are shooting "52's; Because the headspace is controlled primarily by the cam action when closing the bolt... It is important to keep those cam surfaces well lubricated.)

During a trip to the Winchester factory to shoot in the Connecticut State Championship matches, a Winchester representative volunteered to correct the headspace problem by supplying a whole new bolt assembly. The rifle has been shooting well ever since.

Then came a period during which it became necessary to turn my attention to more pressing matters. That is to say, I had a family, I had a job that was becoming more demanding, and in general the time available for shooting activities was seriously curtailed. It became more and more difficult to get out to a league match once a week. Practice sessions were either short or nonexistent. I became a rather unreliable member of the team, and slowly drifted away from active competition.

I was certainly not alone in this situation. Many of my shooting buddies seemed to be experiencing much the same fate. Many moved away to other locations. Some sold their "stuff" and quit altogether, others just put it in the closet and forgot about shooting for a while. Another development which contributed to a decline in shooting competition was the fact that it was becoming more and more difficult to support a good competitive facility. Certainly in the New York Metropolitan area the cost of maintaining a rifle range became highly prohibitive. Many clubs disbanded or merged thus reducing the quantity and quality of the competition. The public attitude toward shooting sports had seriously deteriorated. It just wasn't all that much FUN anymore.

So for something like 20 years I abstained from shooting competition. It's not that I didn't want to shoot, it's just that I had become a product of my environment. I went to work, I came home, I cut the grass, I did my chores, and perhaps every once in a while I might get the rifle out and go to a range just to see if I could still "do it". Without practice I got very rusty, and discouraged. With time, the excursions to the range became less frequent.

Then several things changed which altered my environment. I moved to West Virginia. That in itself did not cause an immediate reinvolvement in competitive shooting, but in casual conversation with a new acquaintance I mentioned that I liked to shoot. He in turn invited me to join the local shooting club. I became a member of the Jefferson County Izaak Walton League and Leetown Gun Club. For the first year I would attend an occasional club meeting and might go once in a while to do some shot gun shooting, but there was no serious involvement in rifle competition.

Early this year, I got a new neighbor. Milt Cook moved into the house across the street. Milt, as some of you might know is the originator of the International Rimfire 50/50 style competition. Since we are naturally friendly people, my wife and I introduced ourselves to Milt and his wife. During the conversation, somehow it came out that I was a member of Izaak Walton and that I liked to shoot. Well... the next thing I knew I was signed up to compete in an IR 50/50 rifle match at the club. The Winchester 52 was too heavy (17 pounds with sight) to be eligible for even the 13 1/2 pound class, so I decided to use a rifle that my father-in-law had

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brought me from Germany. It is a Weihrauch falling block action with a medium heavy barrel. The rifle is stocked in a style commonly used in German indoor (gallery) matches. The rifle weighs about 9 1/2 pounds but with the Unertl 20x mounted it came to over 11 pounds. So I entered the heavy rifle class. Being an old position shooter and used to waving the rifle around while standing on my hind legs, I figured that this kind of shooting would be a snap. Shooting from a rest while sitting at a bench.... how could you miss!

....Oh! what a rude awakening.

First of all, they made the target small, I mean really small. It was almost like shooting at the old 50 foot target but they pushed it out to 50 yards. Then of course there was the fact that the bullets were not going where I thought I had aimed them. The results of that match were a disaster. My ego had suffered a serious injury. My actual score was 220 out of a possible 250. The result was that I placed somewhere in the bottom 10% of the competitors.

Although the experience was humbling, I began to take a reality check. I started to look around at what some of the other guys were shooting and discovered there were more custom built rifles than I had ever seen at a match before. These guys were serious. Then there was the revelation that they did a lot of practicing. The conversations after the shooting were also very enlightening. Talk about ammo, talk about bedding, talk about barrel care (inside and out), scopes, triggers, and wind... always the wind.

It quickly became obvious that if I wanted to compete, and there was no doubt in my mind that I did, more dedication on my part would be necessary. This was not going to be a situation where I could just show up at a match, casually shoot and walk away with a winning score. I would have to work for it. First of all I needed to practice, and the rifle had to be made more accurate. Again with the help of my good neighbor Milt, some modifications were made to the Weirauch so that not only did the accuracy improve, (and that's a whole 'nother story) but by mounting a 16 ounce Lyman 20x on it, we got the total weight down to just under 10 1/2 pounds. Now I could compete in both the 10 1/2 pound and the 13 1/2 pound classes.

The next opportunity to compete in an IR 50/50 match brought much better results. The score had risen to a 240 out of a possible 250. That certainly did not win any accolades, but I went home feeling a good deal better. At least I was in the top 25%. More experimentation and more practice was obviously needed but at least I could hold my head up and say that I had improved.

At the next club shoot, the improvement was substantial. Again using the Weihrauch, I fired a 246-11x in the 10 1/2 pound class and a 244-12x in the 13 1/2 pound class. These were now beginning to be respectable scores. I was up there with the other shooters. i was competitive again. I was also "hooked" on the competition.

Perhaps the real competition is not against the other shooters but against yourself. The ability to improve, to do better than before is probably the key to why some of us keep trying. It is unlikely that my improvement will continue in a geometric progression, but you better believe that the goal will be to do a little better each time. To get just another point or an extra "x", to beat myself and thereby perhaps to surpass some of the other shooters who are all doing likewise. Believe me, the competition is FUN again!

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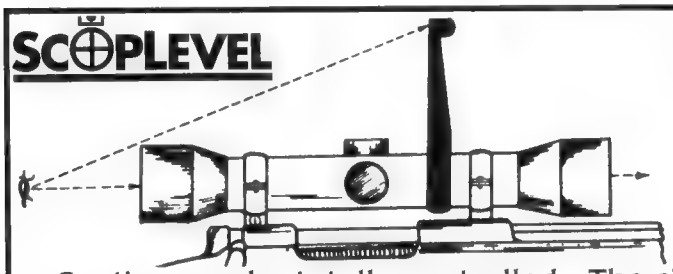

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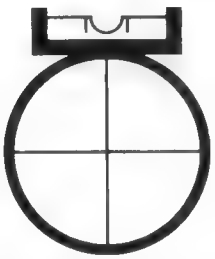

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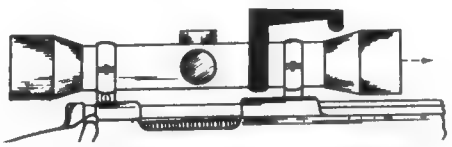

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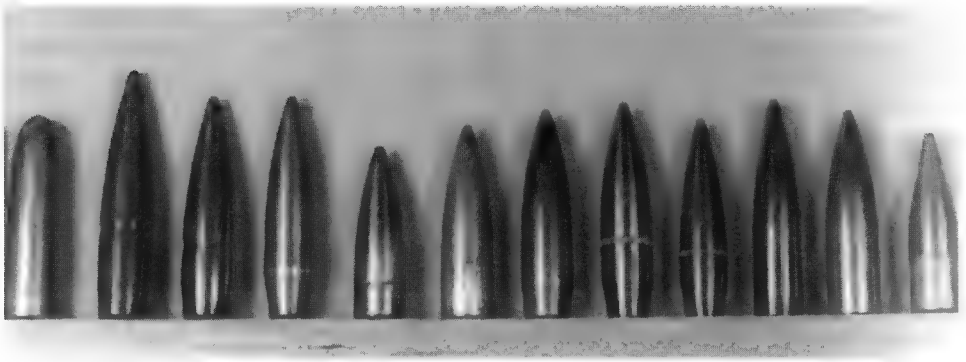
THE EVOLUTION OF THE MATCH BULLET

by

Dr. K.C. Erickson



When my friends and I first became interested in Hipower shooting in 1950, the only ammunition available was DCM issue ball. This was not really too bad stuff because the army made an attempt to select the better lots for us civilians, and some of it shot quite well, especially at the shorter ranges. However, the real test of any such ammunition intended for Hipower shooting is at 600yds. The first match we went to that included 600yds demonstrated this to us rather dramatically.

There were a number of older prewar shooters competing that day who had squirreled away some prewar 1938NM and while we were busy firing 90's and 91's, they were shooting 99's and some possibles. In our innocence, we thought that all ammunition issued by the government was accurate to any range and it never occurred to us that we were being handicapped by our equipment. Even if we had known it, there was no ammunition such as the later Western Super Match or Remington Palma Match available. Neither was Sierra spoiling us with their marvelous line of matchkings. Not in the running either was Hornady, Speer, Nosler, Lapua, not to mention Frankford Arsenal.

A little later, a favorite uncle who had been a competitive shooter, found a handful of 173gr, M1 boattails and gave them to me. Loaded over 46gr of HiVel #2, I shot them in a match with much improved results. At that point I became greatly interested in match bullets, and how vital they were to the aspiring match shooter. E.C. Crossman's books, "Military and Sporting Rifle Shooting" and "The Book of the Springfield" did a great deal to educate me about the different things that had been tried in years past in the development of the match bullet.

Thanks to the efforts of a cartridge collector friend, I managed to get samples of many of the old match cartridges and bullets that did so much to develop the accuracy that we now take so much for granted. I had thought that perhaps some of the readers of "Precision Shooting" might enjoy seeing some of these old innovative bullet ideas and perhaps try a few of them in a more modern application.

Prior to 1880, the typical military bullet looked like bullet No. 1 on the left side of the picture. This of course is the 220gr. .30 cal. Krag bullet, jacketed with cupro nickel. Some of the early Krag cartridges had bullets jacketed in steel with a thin coating of cupro nickel. Fired at modest velocities, there was no serious problem with metal fouling, and in spite of relaxed tolerances, the rifles shot well enough for target work.

Bullet No. 2 is the one to which we owe much of our gratitude for the marvelously accurate bullets of today. This is the famous French Balle "D" developed in the early 1880's and kept secret by the French until well into WW1. The first bullet to incorporate both the spitzer point and the boat tail, this 8mm bullet weighs about 198 grains and is made from solid bronze. I have carefully examined the several specimens I have, and I cannot detect whether they are turned on a lathe, or just how they were fabricated. The crimping groove is turned, since chatter marks are visible, and the date of manufacture is stamped into the base. The ones I have are not very uniform, since both the diameter and the weight vary. It is interesting to note that Elmer Keith tested some solid bronze bullets in a .220 Swift when that cartridge first appeared, and reported excellent accuracy.

Bullet No. 3 is the belated German copy of the Balle D, introduced in the tail end of WW1. This is an 8mm bullet also, and is jacketed in copper clad steel. It weighs 197 grains.

Bullet No. 4 is the one that is rarely mentioned, but one that deserves more recognition. This is the Swiss 194 grain .30 cal. bullet developed in 1914 — really the first improvement of the Balle D. If you look at the profile of the US M1 173 grain boat tail, you can see that they are almost duplicates. This bullet is again, jacketed in steel clad with cupro nickel.

Bullet No. 5 is the good old 150 grain service bullet from the .30-06 WW1 cartridge. Jacketed with cupro nickel and shot at velocities in the 2700 fps, it performed well when of good quality, but was prone to metal foul. This was used for competition shooting in the 1919 matches, and for a long time after the war by both National Guard and civilians alike.

Bullet No. 6 is the famous (or infamous) 170 grain "Tin Can" bullet used in the 1921 National Matches. This is nothing more than the 1920 170 grain bullet jacketed in cupro nickel, but with an electrolytically deposited coating of tin. The idea was to minimize or eliminate the serious metal fouling resulting from such bullets being fired at velocities exceeding 2400 fps. The story (or legend) said that the tin "cold soldered" itself to the neck

of the cartridge case, resulting in abnormally high pressures, blown-up rifles, etc. In recent years, most authorities have concluded that the problem really resulted from the pernicious habit many shooters had of dipping the bullet into Mobillubricant before loading and firing. The fact is, I have two clips of original 1921 NM cartridges I obtained from the estate of an old friend and Camp Perry shooter, several of which have season cracked necks. The bullets could be removed with the fingers.

Bullet No. 7 is our government's first form of boat tail development, the 1922 6 degree, 170 grain bullet. Jacketed with the new gilding metal, much of the problem with metal fouling went away.

Bullet No. 8 is the parent form of bullet that most of our match bullets of today are derived from. This is the service M1 boat tail, 173 grain, that was loaded in the .30-06 from 1925 to the beginning of WW2. It was of course, jacketed with gilding metal, and in selected lots shot as well as our modern bullets do. Crossman mentioned in his book that the 1925 and 1929 National Match cartridges would shoot into 2.6" at 300 meters (328 yds.). Frankford Arsenal turned out a number of specialty loads for the Olympics and International matches, using this bullet, and some of these contained bullets that were uncannelured.

Bullet No. 9 is the .276 Pederson bullet that was developed but never put into production for service use. The bullet is jacketed in gilding metal, weighs 125 grains and is .284 diameter.

Bullet No. 10 is the .280 Ross, jacketed in steel with a graphite and wax coating, it was .287 in diameter and weighed 150 grains. This most unusual bullet has a very deep hollow point, which I discovered by X-raying it down to my office, and also a hollow base. The hollow in the base is not cup-shaped, but a very nicely detailed cone. Developed to use in the Ross match rifles of 1909-1914, it won everything in sight.

Bullet No. 11 is Winchester's answer to the Ross bullet. This is a 180 grain flat base match bullet jacketed in cupro nickel for use in the new Springfield .30-06. It was brought out for target shooting in 1914. Remington also made at one time, a 200 grain flat base match bullet, also jacketed in cupro nickel. Crossman states that he did not understand why Remington persisted in using that jacket material, when most others were using gilding metal, but that he would not criticize anyone who could make cartridges that shot that well.

Bullet No. 12 is the little known Thomas Pencil Point .30 cal., weight 172 grains, jacketed in cupro nickel. This was one of the first, if not the first, commercial match ammunition available to the competitive shooter after the .30-06 was introduced. I have often wondered if Joyce Hornady saw this bullet and was thus inspired to create his secant ogive series of bullets from the idea.

One of the facts that has always interested me and yet has eluded my research efforts is why the early bullet makers persisted in using cupro nickel for a jacket material. Crossman made a passing reference to the ease with which it could be drawn into jacket cups, and that it took awhile until Frankford Arsenal learned to fabricate jackets with the new gilding metal. Cupro nickel not only created the serious metal fouling problems with bullets fired at higher velocities, but it had to be considerably more expensive to use. Perhaps the modern bullet makers are missing a bet in not trying to turn out super accurate bullets using it, or at least doing some research on the subject.

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Stock Up! — Building Your Own Epoxy/Fiberglass Stock

by

Bob Latino

If you're like me you probably have one or two long guns in your collection that for whatever reason sit in a stock that just doesn't suit you. Maybe the length of pull is too long or too short or you wish you had a wider forend for that varmint rifle. Maybe it's just downright ugly! Why let it sit there virtually unused – MAKE a new stock for it! What did you just say – "I can't do that – it's too difficult". Did you ever make model airplanes or cars as a kid? Did you ever do body work on that old clunker you had as a teenager? If your answer to either of these two questions is YES then you probably have the skills necessary to make your own stock!

I recently purchased a used benchrest rifle in good condition at a very attractive price. It was a Stolle Panda glued into a stock that a lot of people use successfully. When fired from the bench, however, I noticed that the gun definitely rode higher in the bags because the stock had more drop than the stock on my present gun (a Panda in an R&M Epoxy/Kevlar stock). The forend was shaped differently and did not fit the front sandbag as well. The rear of the stock was rounded on the bottom, not having the flat 7/16 rail characteristic of the Bob Adamowicz R&M stock. Although both guns have the same action I found it a little strange going back and forth between the two – maybe a little like driving your car and then your wife's car on alternate trips to town. Ergonomics is the correct word. I originally thought the best way to go would be to make an exact copy dimensionally of the R&M stock. After careful consideration, however, I decided to modify the design somewhat to better suit me personally. I would shorten the overall length of the stock from 32 1/2 inches to 31 1/4 inches. This would be accomplished in part by reducing the length of pull from 13 1/2 inches to 13. You don't need a full 13 1/2 inches for a gun that is only shot from the bench. Remington 40XBR's come from the factory with a 13 inch pull. Another 3/4 of an inch would come off the forend – this would still leave 10 3/4 inches from the front of the receiver to the end of the stock. This is about 1/2 inch MORE length than is found on a McMillan benchrest stock. Shortness equals stiffness just like a barrel. A shorter stock also weighs less. The upper part of the buttstock would be flat so I wouldn't inadvertently bang the cleaning rod against the rounded top.

The first trip was to the local craft store where for about 8 dollars I acquired a 2 foot by 4 foot by 2 inch piece of styrofoam. This would provide the form around which the stock would be constructed. The store had about a dozen pieces, only 2 of which were to my eye dead true. You have to have a STRAIGHT piece of styrofoam to start – styrofoam has a tendency to warp and take a permanent set if exposed to heat and/or pressure. A crooked one is useless for stockmaking. A piece this size is good for about 3 stocks.

The next stop was to lay my present rifle onto the styrofoam and lightly trace the outline of the stock in black marker. My modifications were then added to the pattern. You can cut the pattern out with a jigsaw (power or hand). Since styrofoam is relatively weak on its own and can snap, don't use too much pressure on the saw. If it does break you can easily fit the 2 pieces together with epoxy and a few hours later you're back in business. Use rough files (round and flat) and a hacksaw blade to bring the foam closer to the actual size and shape you're after. A 2 inch thick piece of foam is sufficient for most stocks. If you need greater width in any area, as I did for the forend, simply cut out what you need from scrap foam and laminate the piece or pieces onto your pattern with epoxy. Keep your foam slightly under the dimensions you're after. The cloth and binder that you apply will increase your dimension by about 20 thousandths or so with each layer and remember you will be adding to BOTH sides of the stock. I started the forend foam at about 2.7 inches figuring cloth would bump up that figure to about 2.9 and still leave about a tenth of an inch or so for paint. Cut away the foam for the action side rails and barrel channel rails. Any foam here would be so thin as to be virtually useless from the standpoint of weight reduction. Solid action and barrel rails will add to the overall rigidity of the stock.

Early on I decided to use fiberglass cloth in an epoxy binder over the foam. You CANNOT use the polyester resin that is commonly used with fiberglass cloth since it will, in a matter of minutes, DISSOLVE any foam in which it comes in contact. If you want to see a mini "China Syndrome" pour a small blob of polyester resin onto some scrap foam. In 10 minutes it will sink an inch or more into the foam. The stock might be somewhat stronger if Kevlar cloth were used instead of fiberglass cloth – but Kevlar is not commonly available and makes the stock much more difficult to finish and paint. If you have ever worked on a Kevlar stock, as I have, you know what I mean. When you sand an epoxy/Kevlar stock the fibers don't cut completely and your stock looks like a shaggy dog with fibers hanging out. The best approach with one of these stocks is to "paint on" a few coats of clear epoxy and work above the stuff. Fiberglass cloth on the other hand is readily available in the auto department of many stores usually coming in an 8 square foot (2 x 4 foot) size for about 4 dollars. The fibers cut cleanly during the sanding process. Two or three packs will be needed to complete a stock. Although most hardware stores sell epoxy – they usually have it in small quantities. Try an industrial supply outlet – they sell it in larger quantities. You will need 25 to 30 ounces to complete a stock. I used Devcon 2-Ton Clear which I found in a 9 ounce size (Devcon product # S-33) at a large hardware store for 7 dollars. I originally bought 2 packages but needed a third to complete the project. The epoxy sets in about 30 minutes after mixing giving you plenty of working time. In 2 to 3 hours it will be fairly hard and the piece may be handled but you must wait 6 to 8 hours before sanding. If you try to rush and sand too early you'll just gum up the sandpaper. Make sure you measure out exact quantities as specified on the package – too much or too little hardener could cause the epoxy not to completely cure and you may wind up with something the consistency of pine tar on your stock. There is considerably less margin for error here than working with polyester resin where half or double the recom-

mended amount of hardener can still effect a full cure.

After the foam is shaped to your liking, use a vacuum cleaner to pull off all the little chips that have fallen into the pores of the styrofoam. Next mix up about 2 ounces of epoxy/hardener and paint the entire foam pattern with the mixture. This will insure that the first cloth layer has a solid base on which to bond. Make sure to buy a couple dozen "cheapie" throw away brushes and some 3 ounce plastic cups in which to mix the epoxy. I used 10 penny nails to mix each batch. After hardening you can make minor corrections to the foam if needed.

One way to start is to make a mockup of your action in wood. For a Panda action you will need a piece 1.5 inches wide by 8.5 inches long. For a Remington action use a piece of PVC pipe or broom handle about 1.25 inches in diameter. Wrap masking tape around the mockup until it's up to the proper dimension. I wrapped my mockup with about 10 layers of tape all around so the action area would be somewhat oversized leaving room to jockey the action slightly later on if I made an alignment error. It will also leave space for the "glue" on the glue-in. If you do want to use the actual action instead of a mockup be sure to COMPLETELY cover it with masking tape. Apply a release compound to your action mock up. I used polyvinyl alcohol but you can also use a good coating of any carnauba car wax. This will prevent the epoxy from making a permanent bond to your action mock up. Align the mock up as accurately as possible with the foam and use masking tape to temporarily lock it in place. A clamp could bend the foam. Make a slurry of epoxy and small bits of fiberglass cloth cut up about 1/4 to 1/2 inch long and pack it in around the action to fix its position on the foam. Don't worry about the taped area – you can deal with that in the next step. Don't attempt to form the trigger area at this time and the same goes for a magazine area if your action has one. Do that after the stock is complete and with the actual action you will be using. Your action area now has a "fixed" position, so remove the tape that held the mockup and make a form for the action siderails with masking tape similar to the forms made when pouring a concrete foundation. The mock up makes up one side of the form – make up the other side with 2 or 3 layers of masking tape. One layer of tape is too weak and the weight of the epoxy will cause it to sag. You may have to do this in two stages depending on the height of the action siderails. Once the entire action area is fixed on the foam you can make tape forms for the barrel siderails. Try to keep them as straight as possible and again use multiple layers of tape to prevent sagging of the epoxy. If you find a void in the epoxy after removing the tape on this or any other stage of the process – take the time to fill it BEFORE proceeding further.

When applying the cloth don't try to do too large an area at once. As a suggestion to start, do the underside from just in front of the pistol grip to the bottom end of the barrel channel wrapping the cloth up around to the action and barrel channel siderails. Wet down the area first with epoxy and lay on a piece of cloth cut somewhat larger than the area you are trying to cover. Some may feel that alternate layers of cloth should have the grain run at a 45 degree angle to one another for added strength. I'm not entirely sure it makes that much difference in the overall rigidity of the final product. Brush on more epoxy starting at the center and working your way towards the edges of the area you are covering. This will prevent air pockets. Although the cloth is flexible you may have to cut it slightly to wrap it into an area in which there is a drastic change in curvature. Try to keep the brush AWAY from the edges of the cloth – if you don't you'll pull out long strands of fiberglass that will stick to the brush in a big blob. After the epoxy hardens the excess cloth that overhangs can be removed easily with a sanding wheel on a Dremel tool. Do the buttstock and barrel channel areas in similar fashion. After the entire stock is covered with one layer of cloth and is completely hard, inspect carefully for high spots (grind them down), air pockets (grind away the pocket – fill with epoxy), or low spots (again fill with epoxy). Fill the low spots on one side of the stock and tape tightly over the wet epoxy – rotate stock 1/4 turn and do same to the next side. Continue in this fashion until all areas are filled. if you don't tape over the spots the epoxy will run as you rotate the stock. This is now the time to do mild reshaping of surfaces if necessary. Use a 40 to 60 grit paper on a sanding block. Other than building up a small area, I don't recommend putting on more than one layer of fiberglass cloth at once. If you do, you

Continued on next page

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Stock Up! — Building Your Own Epoxy/Fiberglass Stock

Continued

will run the risk of hidden air pockets and partial adhesion.

How many layers do you put on? I would suggest a minimum of 4 to a maximum of 6, although you may want to reinforce certain areas with a little more. Anything over 6 is overkill and remember each layer adds WEIGHT! My stock has 5 layers of cloth and epoxy in all areas and is reinforced at the grip area with 4 more and still weighs only 1 pound 9 1/2 ounces. A stock for a sporter made this way should tip the scales in the 1 pound 5 ounce to 1 pound 7 ounce range.

When you are done check the action and barrel channel rails to make sure they are perpendicular to the buttstock. Lay the stock upside down on the rails on a flat surface and check the butt with a square – you may have to raise or lower one rail. Check to see that there is no wobble to the rails either perpendicular or parallel to the barrel channel. You can also "recast" the rails square by wetting them with epoxy and setting the stock upside down on a flat surface on wax paper to harden while the buttstock is propped into a square position. Use a large flat block to sand them down to the proper height later. I use the underside of one of my loading trays as a sanding block for this operation. Make sure one side of the action area is not appreciably thicker than the other – use calipers to measure from the inner siderail of the cast action cavity to the outside of the stock at various points along the cavity. I also like to cast the butt and barrel end caps in solid epoxy about 1/16 inch thick. Sand the entire stock lightly – the low areas will remain shiny. Fill them with epoxy as before and resand. Your stock is now ready to cut out the trigger area, bolt handle slot and other steps necessary to get ready for paint.

A few final notes. Always wear SAFETY GLASSES when using a small hand grinder (Dremel). You may also want to wear thin rubber gloves when working with the epoxy – they're only about a nickel a piece. If you do get some on your skin, rub some paint thinner on the area BEFORE the epoxy sets up and then follow with some dishwashing soap like Joy and water. Uncured epoxy is easier to remove from the skin than polyester resin. Finally, if you're the type of person that must complete a project in 2 or 3 days – then this one is not for you. Two to three weeks is a more realistic time frame. Good luck!

Bob Latino
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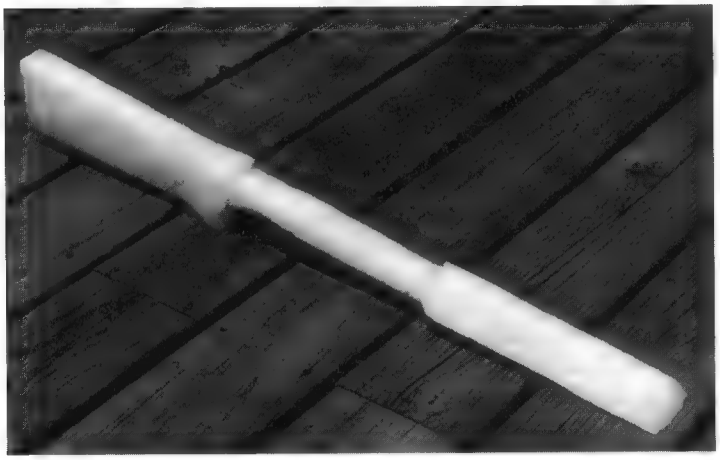
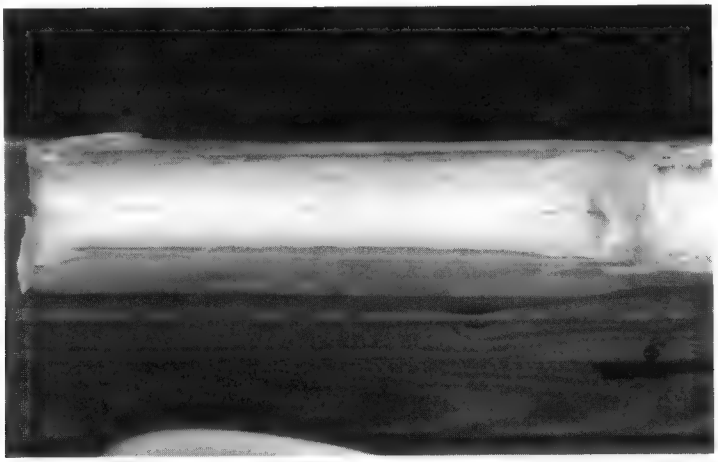
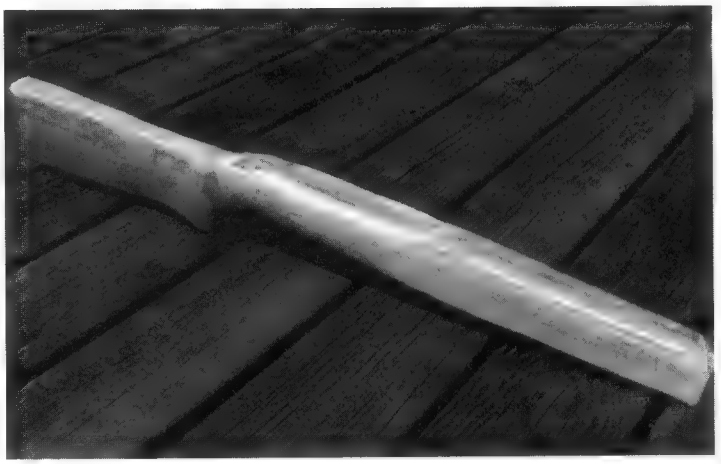


Styrofoam form around which stock is constructed.

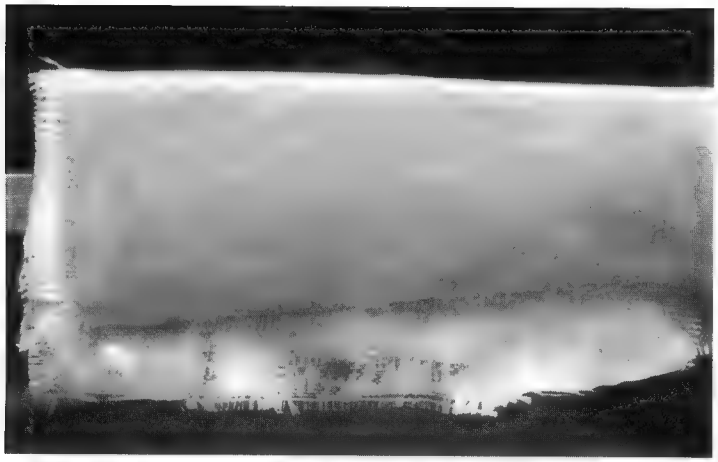
Styrofoam painted with epoxy shown with action mockup.



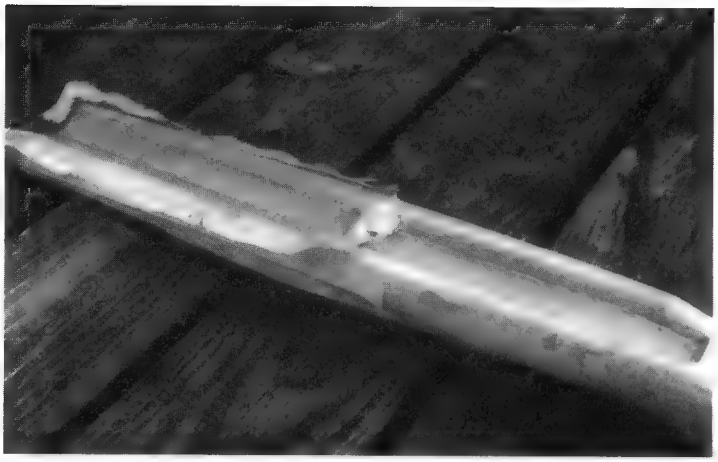
Forming barrel channel side rails in solid epoxy.



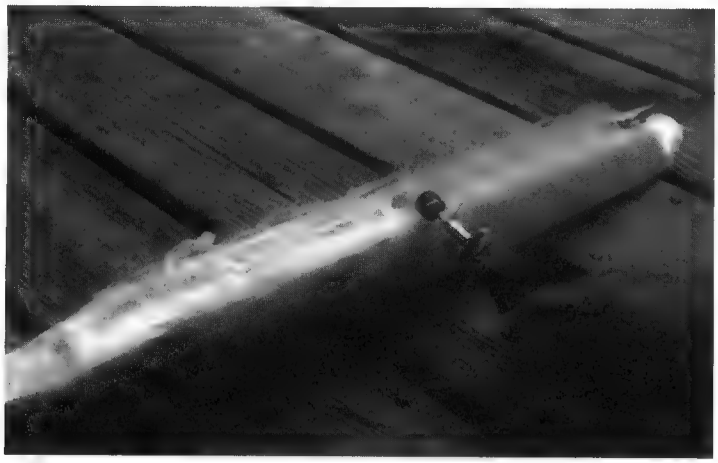
Stock shown with one coat of epoxy and cloth – rough sanded to remove high spots.



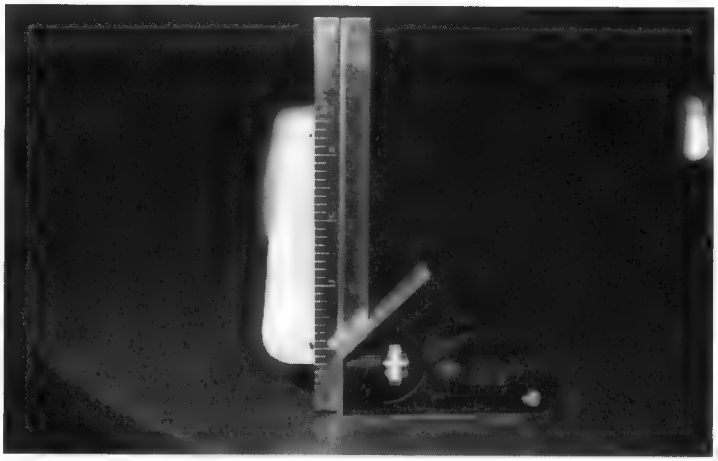
Applying a layer of cloth to the buttstock area.



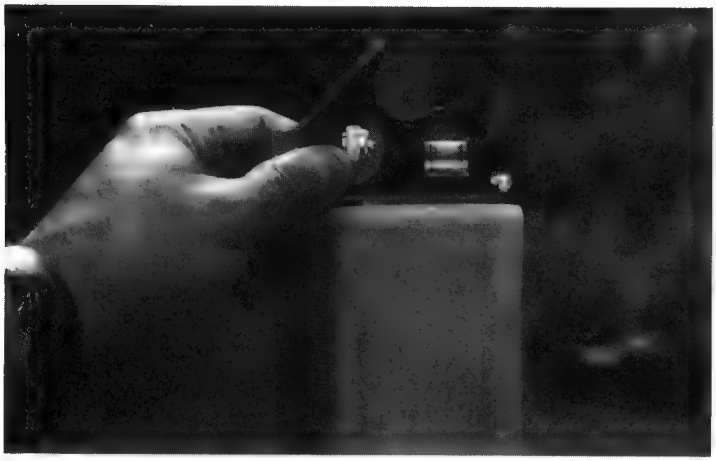
Applying a layer of cloth to barrel channel – action cavity roughed in.



Use a small hand grinder to remove cloth overhang after epoxy has hardened.



Use a square to make sure buttstock is perpendicular to action and barrel channel rails.



Check barrel channel end cap to be sure it's square with barrel channel – this one came out pretty close.

BELOW – Completed stock with 5 layers of cloth – rough sanded and ready to cut out trigger and bolthandle areas.
ABOVE – Another stock made by the author for a Remington 700 in 22-250.

COMING FULL CIRCLE AND THEN SOME!

by

Joe Rychetnik

As far as I can remember, I have been a shooter. The first gun, a single shot .22 Iver Johnson held by a cousin started me out at about the age of seven. Later on, I found out I could earn a similar single shot by selling Liberty or Colliers magazines, and door to door in all the blocks of the neighborhood between home and school (we walked safely six blocks each way each day) the locals were accosted, and I was the first one in my circle of chums to have a real gun. It was put away and only used to shoot under adult supervision but it was mine.

There was a Daisy air rifle one Christmas that was given me to shoot without supervision and I promptly perforated a next door neighbor's bedroom window by shooting at a Prince Albert can seated on a brick to keep it above the snow. All the golden BB's that missed the red can with the Prince on it, bounced upward and left their mark. The Daisy was taken away and my allowance was fully directed to paying off the glazier.

Why I mention all this is I have come to a point in my life, almost 70 and full of aches, pains, and inabilities, to return to those simpler days of plinking. The big red covered Webster's Collegiate on my desk states that plinking is to shoot randomly at targets in an informal and noncompetitive manner, which I have been doing all my life but now more and more.

A "deal" offered in a mail order catalog started me seriously on this final process. I was able to buy a GI ammo box full (1000 rounds!) of Remington LR cartridges for $30, which makes more of this fun shooting affordable in my retirement. Nowadays $30 is a significant sum to me.

It used to be a box of shorts was about 35 cents and LR's 50 cents but today 3 cents a shot seems a bargain. There is no need for the extra range and power of the LR shell for beer cans and other desert clutter I fire at but one never knows when a "long range" target will present itself and that extra flat trajectory will be useful.

Extra power has been the driving force behind the firearms and ammunition makers sales strategies since the days following smokeless powder. In my collection of handguns there seems to be a line of pistols ranging from a .22 single shot "target" revolver to an 8+ inch barrel Model 29 Smith that has taken wild boars, black bears, and a moose once. More power!

The same for the rifles in the "battery" although I soon learned that magnum rifles were not the kind I needed — everything I hunted fell to calibers built around the .30-06 which allowed less painful practice on the 200 yard off-hand drill our Carmel valley gun club advocated.

Ten or twelve of us lined up every Sunday 10 a.m. to fire offhand at the 200 yard bull, which gave us confidence when it came to our annual joint and separate hunts for both deer and wild boar. Shooting from the hind legs is the only shooting that counts, we were told. I agree!

Most of that activity is behind me now. When I head for the desert range these days in the Jeep, a .22 rifle and a .22 pistol are usually all I take and seem happier for doing it.

I have all but given up the quest for ultimate accuracy in what's left of my long guns, as I have run out of steam to follow that long and pot-holed road. The latest (June 1995) issue of The American Rifleman, or TAR, as it is called back at NRA bunker, has me convinced that all those careful efforts to reduce the chances of missing our personal bullseyes has been turned ass over tea kettle by a fellow named Don Bower who lives in the shadow of the Front Range in Colorado. Bower has performed shooting magic in a very simple way, TAR reports. (Coloradans keep coming up with some great ideas!)

I have a feeling that Merrill Martin, that immaculate and truth seeking investigator of rifled accuracy will be hard after the Bower technology and may very well match or beat it. Friend Martin likes such a challenge as do several other writers of the gospel according to PS. I'm sitting this one out and will watch with amusement as ranges get longer and groups get smaller with the new technology. I can't hold that well or can I afford the mental and mechanical anguish that goes with learning a new game.

What I liked about the report on Bower's prowess by John Eaton, an NRA regional director for Colorado, is that he used a chunk of steel plate for a target. I have been an advocate of steel plate targets for years and have fought with my own gun club members to install such targets to improve both casual offhand shooting and precision shooting.

The Steel animals used in silhouette shooting have long been adopted. I have a tiny set of such animals I use with my Diana air rifle at 33 feet, shooting across my patio.

A steel plate of one foot square, hanging by stout chains from a steel pipe frame well away from the target have offered me a lot of fun with center fire rifles. I have been shooting (off hand) at a steel plate a few weeks before hunting season every year since I came south from Alaska.

The foot square target is about the size of the "boiler room" of a big game animal. A hunter should be able to hit regularly this size target. I taught one of my wives to become very proficient with her slide action '06 Remington, starting her at 25 yards and backing off in 25 yard increments to 125 yards. She got to clang the plate with every shot.

She wore glasses that gave her a problem with a scope sight. I had a Williams Guide Sight installed and a Redfield Sourdough front sight and she seldom missed the plate from the longest range off hand. That's all she wanted to be able to do and she took a moose or two every season in Alaska for years. She never practiced except just before hunting season.

The clang of the steel plate (I have never heard or seen any so called ricochets, and that threat for years kept a steel plate target off our club range — the impulse seems to move the plate enough to spatter the bullet on the ground near by) is a great confidence builder.

I don't think it makes a hoot if the bullet is an inch or two this way or that when it comes to big game animals but the ability to drive a hole into the vital area the first shot is very important. Firing on a properly sized hanging steel target at various ranges off hand will insure that skill.

I have a feeling that the spray used to cover the steel target used by Don Bowers will get some play. I expect a firm to come out with "Quarter-Mile White" soon. The problem I see is getting someone to stand off at that quarter of a mile with the spray can poised to spot hits

and re-spray the plate. Even Bower's silver dollar sized splatters at a quarter of a mile will demand some verification. The 20X scope will do for now but soon we will see portable TV cameras that can be clipped to a nearby branch, that will monitor the hits. I think Don Bower has done something to give precision shooting another nudge towards that ideal, the one hole group.

The .30-30 lever action rifle in both the Marlin and Winchester styles has for years, and may still be, the most common deer rifle in the country. The caliber has always been considered a shabby one when it comes to accuracy. The lever gun was looked down on by folks with bolt rifles in every hunting camp I was ever privileged to share. I have always wondered why the .30-30 was so damned. Then one day at a camp up in Northern California, near Geyser Peak, where all members were obliged to report two days early for work parties and rest, a fellow showed up with both a .30-30 Winchester '94 and a superbly stocked and finished Model 54 Winchester in .30-30.

The Model 54 (I do love that little rifle!) was equipped with a Lyman scope of four power with ordinary medium crosshairs — a hunting outfit. We all went to the 100 yard range to sight or re sight in as many of the gang never fired their deer rifles from season to season and a box of shells went for maybe five years. There are an amazing few real gun nuts in any hunting group just as there are an amazing few gun nuts among policemen whose lives depend on shooting skills.

After we had put our groups on the target (3 inch bullseye) in more or less decent fashion, most of them two or three inches above the center as the good book says, Randall proceeded to destroy a myth about the .30-30. He fired five shots from the lever gun over iron sights and we saw emerge the usual wide open three inch plus group print out around the bullseye. He went down and pasted these holes with white pasters — none of the holes had been dead center.

He then took five rounds from the same box and fired the Model 54 with the scope. We were all spotting through scopes and glasses and were shocked to see a cluster of less than an inch — three shots touching — appear an inch above the bullseye.

"There is nothing inherently wrong with the .30-30 cartridge — it's the rifle it is shot in that's at fault," he said to us all. Another fellow shot the Model 54 at a fresh target and came up with almost the same fine group. We had a new respect for the common deer cartridge. By the way, Randall prided himself on always trying for a neck shot, to keep from bruising the freezer meat. "You either miss clean or drop the buck like a ton of bricks — the .30-30 will do that easily," he reported and we knew him to not tell stories. But then he never tried long shots and was a fair stalker of venison.

My recent savings from a variety of non-reportable income earning schemes has me now paid up on a new, Ruger 10/22 by that famous competition shooter and gun technician Jim Clark. It does cost an arm and a leg for what will turn out to be for me a quality plinker, but Whelen said that only accurate guns are interesting and I'd think it was time to tag my Bud cans with a fine target-competition self loader. That .22 will be all I'll ever need to see me to my final days and it will be something of value to pass along to my shooting son. And his shooting son.

Glenda has always shared my interest in plinking, considering it more fun and far more practical than punching holes in a bullseye. Her favorite rifle was a neat little Browning self loader that was apparently designed with female shooters in mind. It had but factory sights but she loved to drive cans crazy with it. When a miscreant ripped off the Browning from a stout storage locker in a friend's home some years back, we never replaced it.

A lesson learned from that tragedy was that insurance that I thought covered all my guns and cameras — a home owners floater they called it, did not and usually does not cover such property stored elsewhere. Neither does the insurance of the homeowner where it is stored. We had left both Browning O/U 12 gauge and the Browning plinker at a friend's home near where we were duck hunting. A thief broke in, stole guns, ski gear, and other valuables and I got zip on a recovery claim.

I had a .22 Remington Nylon 66 that I carried on patrol in Alaska that had a nice 4X Leupold scope on top and that had survived all sorts of foul weather and never failed to work. Glenda took to that gun, even though it lacked the grace and fine lines of the steel and wood Browning. Now her eyes find the scope a blessing. We will end our days walking through the sage, rifles at the ready, waiting for whatever tempts the eye. The soda pop and beer cans are inexhaustible where we live. They blow with the wind like tumble weed and flash in the sun to lure your eye. We share many an hour plinking away, and not spending too much. No big cleaning hassle when we get home. The .22 is an old man's dream gun.

I was part of a panel that appeared on a local sportsmans' show some years back and we grey-heads were asked by the moderator some questions about guns that always elicit argumentative and strong opinions from long time shooters. There was the question of who should be allowed to have guns at home. The moderator asked why not lock up hunting guns from season to season, at some secure police type storage. We were vehemently opposed to any regulation that took the gun from our handling.

To pick up a favorite gun — pistol or rifle or even shotgun, is part of the pleasure of ownership. The very act does release a flood of very happy memories of shoots and hunts long past. Just wiping an oily rag over a familiar fire arm has soothing and beneficial effect on the soul. Too many people today are born and raised away from any sort of gun and the moderator admitted he did not even touch a gun of any kind until he was in the Army being trained for Vietnam skirmishing.

Then came the question that passed from one to the other of us and there were no two responses alike from five old hunters and shooters. If you had to choose only one gun to spend the rest of your life with what would it be.

I immediately asked about the prevailing circumstances. Was it a survival situation, a gentle retirement, or were we asked to select a firearms for all situations. The moderator was taken back as he didn't feel that it made any difference. It was a free for all until he said he wanted no particular situation to be prevalent. We all said "the .22!" Rifle, pistol, whatever, it was the universal and most useful of all. A brick of 500 rounds of good Long Rifle ammo could carry a fellow through to his dying days, plinking a bit along the way.

I'll be pleased as punch if that Clark 10/22 is half as good as the Clark people claim. The Jim Clark firm has moved to a new location in Princeton, LA — a roomier shop on Shoot-Out Lane. At least in that small town just east of Shreveport folks are not scared breathless by naming such a venue in colorful terms. I really want to see the year 2000 ring in and I hope by that time we will see the pendulum of opinion swing all the way back to when a guy loading a hunting rifle and kit into his jeep was not a signal for every neighbor to call the police and when sportsmen could speak of guns and gun sports in sounds above a whisper.

Some Adventures of a Beginning Shooter

by
Jay Burleson

A little over a year ago, I made the mistake of asking a gunsmith friend of mine, Mac McCluskey, what he would charge me to put together a simple, custom .308 rifle. I can hear most of you snickering now. Since I had never been a hunter (If I am going to tromp through the backwoods, I'd rather carry 40 lb. of camera gear than a 10 lb. rifle. Go figure.), all of my previous firearms experience was restricted to shooting pistols of various calibers. In fact, I had only shot a rifle a dozen or so times in my life, and never for accuracy. After I had been involved in several adventures with Mac, I began to have a nagging voice in my head tell me how much fun it would be to shoot a big thunderstick. I knew enough (or so I thought) to think that I wanted a .308, mainly because it has a reputation of being a very accurate cartridge. Also, since I am a military history buff, and an admirer of Marine Corps Gunnery Sgt. Carlos Hathcock's sniping missions during Vietnam, this could become a project to have a rifle equivalent to what the military used for sniping. So, just for fun, I asked the fatal question. Mac responded with a figure, and I gulped, nodded and said "Boy, it would be nice if I could afford it!" and promptly put the whole idea out of my mind. Imagine my surprise several weeks later when Mac tells me that he's found a great action for me, and my custom barrel would be arriving in a month! I went over to his shop to tell him that a big mistake had been made, and he had better not order anything else. But as soon as I got there, he laid out the action and the stock. I saw in my mind what the rifle would look like, and I knew right then I *had* to have it. (Has this happened to anyone else?) All I had to do was be able to afford it. Conveniently enough, Mac and I are both photographers, and we were able to come up with a reasonable agreement. I would give him enough money to buy a telephoto lens he wanted (or to pay off the national debt of a small South American country; his choice), and he would give me a rifle. So my odyssey began.

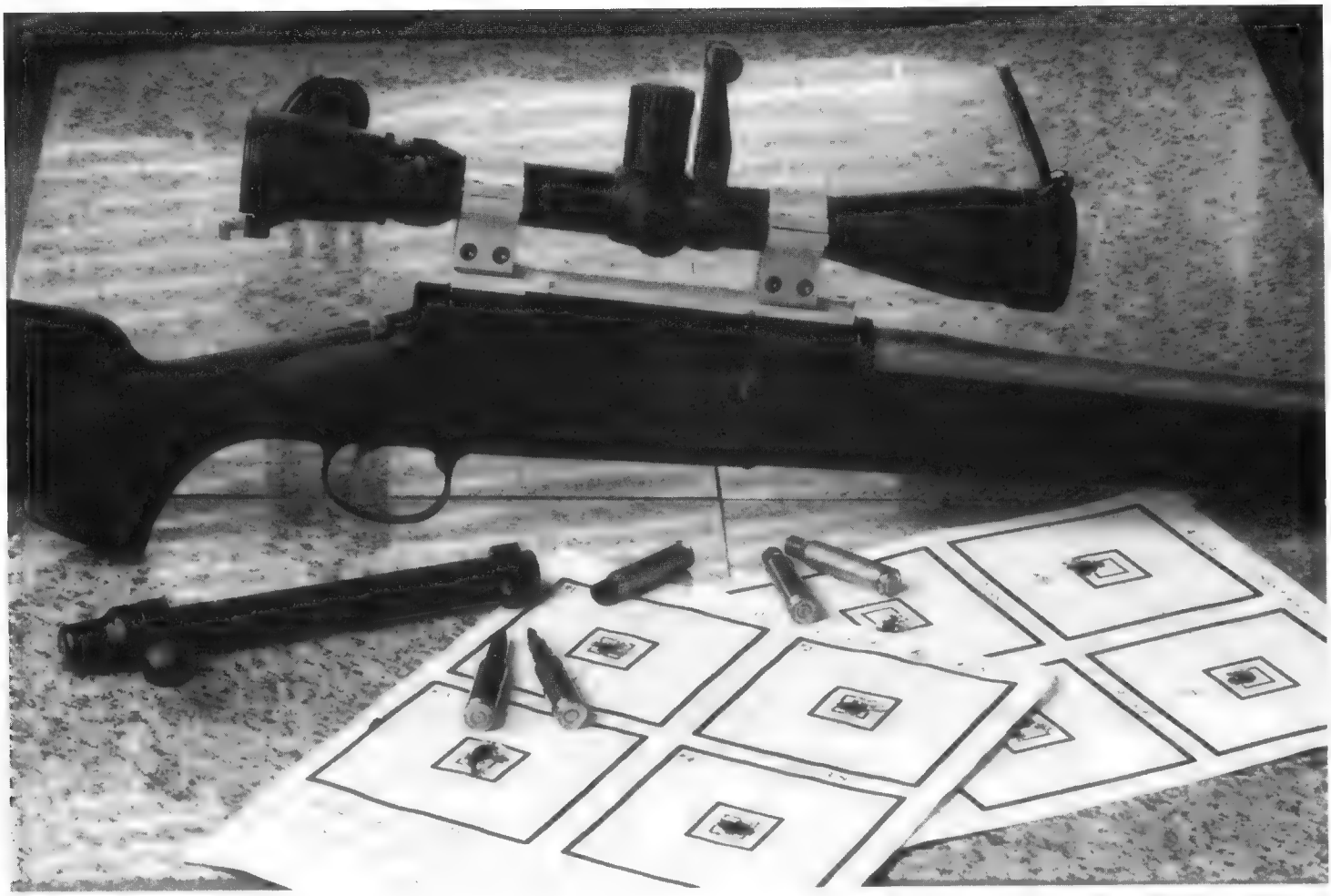
I thought to myself, how hard can it be, building a rifle? What I didn't know, is all the little details that Mac, or any good benchrest gunsmith, does in the process of turning a basic rifle into a custom piece. True up the action, lap the bolt lugs, square the bolt face, pillar bed the action, free float the barrel (I heard that was good), install a Jewell trigger, ream a tight-neck chamber, match prepare the brass, and on, and on. I swear, my eyes glazed over as he told me all of this. All I wanted to do was make it go bang. The next thing Mac heard from me was "How much will all the rest cost?". It seems that I *had* to have a front and rear rest, wind flags, cleaning equipment, loading dies and arbor press (what do you mean, the Wilson dies won't screw into my Rockchucker press?), brass preparation tools, calipers, micrometers and a Sherpa to carry it all to the range. I was used to a .45 and a couple of mags on my belt, 100 rounds of good handloads, some targets, and ear and eye protection. That would keep me happy for a couple of hours. And this loading cartridges at the range business! That's yet another box of stuff to shoehorn into the car! I was starting to worry that I wouldn't be qualified to shoot this new wondergun.

As the project went along, I became more involved. Mac loaned me his copy of Glenn Newick's book *The Ultimate in Rifle Accuracy,* and some of what we were doing started to make sense. Then we started to prepare the brass. I was used to shooting a round of brass 4 or 5 times, and then it was history. Here I was being told that these 40 cases would probably last the life of the barrel! But, as Mac and I sat and reamed the primer pockets, de-burred the flash holes, trimmed to length, squared the case heads, reamed the inside of the necks, and finally turned the outside of the necks, he gave me an education. He told me all that he knew about what happens when you pull the trigger, and the bullet "is born", and starts on it's flight down the bore. He showed me that the preparation work we were doing would help keep everything aligned as each round was assembled, and consistent from shot to shot. He also explained the theory behind a tight necked chamber, in that there is so little movement of brass, the life of each case is extraordinary. It also has the benefit of keeping each round lined up in the chamber very consistently, with no slop. Consistency is accuracy, and accuracy is consistency. All of this information was a gold mine, especially since it was explained so clearly.

Just in time for Christmas 1993, the day finally came when I was able to bring my baby home, and show it off to an admiring group of friends. A good buddy, who is a dedicated hunter, put it up to his shoulder, looked through the scope, touched the 8 oz. trigger, and promptly told me I was insane. I laughed and told him that I felt the same way, and I hadn't even shot it yet!

What I ended up with, sitting on my new rest and sandbags, was a 24" free floating, .308 caliber, 1 in 12 twist Lilja stainless steel barrel, with a tight-neck .332" chamber, screwed into a trued Remington 700 action, touched off by a Jewell trigger adjusted to 8 oz., all pillar bedded into a Pacific Research fiberglass stock, and topped with a Leupold 3.5x10 Tactical scope mounted in Kelbly rings. And it looked awesome.

So, here we are, down at the range. I am all ready for a day of shooting bliss, punching holes until it's too dark to see. Too soon, I find out about *Cleaning The Barrel.* One shot, clean. One shot, clean. I start to feel like a pool room hustler, my arm's moving back and forth so much. After a while, I am allowed to move on to two shots and clean. I am feeling pretty good, the holes are really close together! Unfortunately for me, they are closer together when Mac shoots. The Lilja bar-



rel is great. After 20 rounds, I go to three shots between cleaning, and not a trace of fouling. Everyone here at the range tells me that developing a load for .308 should be a piece of cake. Fill up the case with 4895, seat a Sierra 168 gr. HPBT into the lands, and let 'er rip! Well, I try powder charge weights from 39 grains up to 44.5 grains (too hot). I like shooting three shots into a 2" circle at 100 yards, but I am told it could be a lot better. Heaven forbid, this .308 does not like 4895! I try H335, mainly because it meters well, and that seems to do the trick. 44.5 grains gives me .75" groups, which everyone agrees is not terribly bad for a 10x scope, and it being my first time.

I went home with a big smile on my face. I am hooked. Like many people who have never tried, I had no idea how hard it would be to put each bullet into the same hole, or, failing that, near one another. It's the 1990's, for crying out loud. Technology, regardless of technique, should be able to give us a small group! In my quest to figure out why this game isn't so easy, I became a subscriber to *Precision Shooting*. Another eye opener! People writing articles who understand what a tight necked chamber is and why I can't put factory ammunition into my rifle! (Well, I probably could force a round in, but only once.) And then, I received a Sinclair catalog! I go way over my budget after looking at the first few pages. A beginning shooter can be overwhelmed by information and equipment very quickly. I was lucky. I got a package deal in which I received every piece of equipment and accessory I had to have to shoot with, right at the beginning. But, some of that equipment was old, and could be replaced with shiny new things. And of course, there are *so* many gadgets available to shooters that make life easier!

So now my education commences. After a couple of trips to the range, all of my cases are fire-formed, and I seem to have a good load with H335. I start to play around with seating depth. I end up moving the bullet back ten thousandths, so I have a short jump. That drops my 5 shot group size from .75" to a pretty consistent .5". To me, that seems pretty damn good.

At some point, I figured out that you will learn things even if you are not paying attention. I was dutifully putting out wind flags every time I shot, but I would just glance at them occasionally. After a period of time, I became aware that wind really did have an influence on that big .308 bullet. So far, being aware of what the wind can do has not helped me a great deal. It seems to confuse me even more. Although, now every time I shoot, I can see and understand more of the cause and effect of the wind. Bag handling also. In the beginning, I thought

Continued on next page

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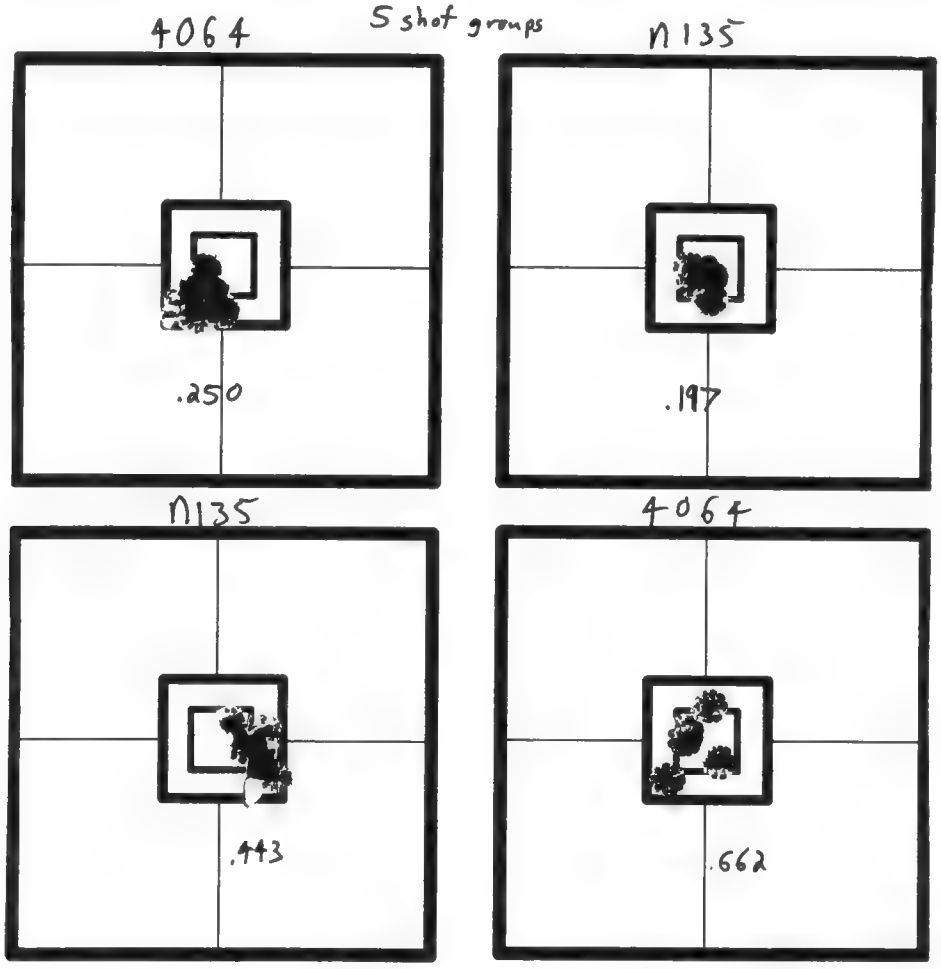
SOME ADVENTURES OF A BEGINNING SHOOTER

Continued

how could it matter where the rifle is, as long as the crosshairs were on the same aiming point? I learned quickly that really does matter. Giving another plug, after reading issues of *Precision Shooting* dating back to 1985, I started to figure out that I didn't have to reinvent the wheel. All the writers already have. Everybody makes the same mistakes. Some people are able to write well enough to let someone else learn from theirs.

In the early spring of 1994, I felt confident enough of my shooting abilities to start looking at some other powders, and maybe some different bullets. Before I had the chance to do any testing, something happened. Let me tell you a story. (By the way, what's the difference between a fairy tale and a shooting story? A fairy tale starts with "Once upon a time. . .", and a shooting story starts with "No sh#$. . ."!) One fine day I was out shooting with some friends. It was one of those rare spring days of blue sky, calm winds, and an unusually warm 70 degrees. As I sat in the sun, with my loading block of cartridges next to me, I started to shoot a second group of five. I noticed after the fourth shot, the bolt was a little stiff. I didn't think to much of it, as it was just stiff enough so that it felt different. I'm sure you can guess what happens next. I touched the trigger, the rifle made a peculiar bang, and smoke started to come out from around the bolt. Believe me, it is one thing to read about high pressure, but to experience it first hand is really exciting. I was able to lift the bolt by standing over the action, and pressing down on it while pulling up on the bolt handle. The case fell out, along with what was left of the primer. I was very lucky. There was no damage to either the rifle or me. Thank you, Mike Walker and Remington. All of my load development had been done in winter temperatures of around 35 to 45 degrees. The effect of temperature on



DATE: 1-21-95 TEMP: 45° WEATHER: Clear WIND: None

RANGE: 100 yds SCOPE: 6.5x20@20 PRIMER: Rem 7½ SEATER STEM:

CALIBER: .308 BULLET: 168 HPBT POWDER: 4064 / N135 WEIGHT: 42.4 / 41.5

Target by Thomas Jay Burleson, 1994

pressure was something that I had not come across. As I discussed this with my more educated colleagues, it was determined that I sat right at the edge of high pressure in the load that I had been shooting, and all that it took was a 70 degree day, a loading block in the sun, and a hot rifle before it went over the edge. Looking at my brass showed that several of the primer pockets were starting to loosen up. Not enough, however, for someone new to the game to notice. After being shown and feeling the difference, I could now tell. I called Sierra, and they didn't have any set formulas for calculating pressure rise as temperatures increase. Something about too many variables for it to be a set figure. One day I should experiment, but for now, prepped cases are too rare!

So that experience tells me that I must find another powder. First I try Winchester 748 (I love metering ball powder), and I run into the same pressure problems as H335. It is an accurate powder, however. I call Sierra again, and I am told the powder that they use for accuracy testing on their 168 gr. HPBT bullet is IMR4064. I end up at 42.4 grains and that load turns out to be the bee's knees. No signs of pressure, and several .375" groups of five. I have access to a chronograph for a couple of strings, and I get an average velocity of 2550 fps. I really like what I get with this powder, but I hate metering it! I want to try some of the Vihtavuori N-135, since it has a burn rate very close to 4064, but I can't manage to find any.

I continue to shoot through the summer and fall, working on my bag technique and wind doping. I seem to stay consistent with all of my groups averaging at .350". Occasionally I will scare myself with a .2" or smaller, but it's pretty rare. I start practicing with my scope set down to 6x, as I have a desire to start competing in Hunter class next year. I would start now, but I work Saturdays and it's hard to make it to the matches. In December, I attend a shoot set up by Richard Nicol, P.S. staff photographer, and a good friend of mine. He is running a monthly Hunter Rifle score shoot. I figure it is time to put my money where my bullets are. I am pleased with my results. I manage to take 2nd place at 100 yards, and 4th at 200. I think I could have done better at 200, but I didn't have enough sighter cartridges loaded, so I had to shoot for the record without my scope set perfectly. Live and learn. We also shot a 300 yard target, 2 sighters and 1 record shot. The person with the closest shot to the X-ring would win. I am proud to say, in my first time ever shooting at 300 yards, that I won!

Now I have a chance to test some powder, and a reason. Anything to be able to come back and win the next competition! I manage to find some Vihtavuori N-135 to use. I am taking a wild stab at this, all I know is that N-135 is used in the NATO 7.62mm issue rounds, so it seems to be a good place to start. If my rifle doesn't seem to like it, I'll get some N-140. Without any adjustment for seating depth, I seem to have a good trend going. With 41.5 grains in the case, six 5-shot groups get me an average of .3831" at 100 yards. This includes one group of .117", and another of .316". At 200 yards, I average .7956", with one group showing 4 shots in .312", with the last shot opening it up to .834". It was sun shining and not a breath of wind. Bug hole fever, I guess. I have a velocity of 2575 fps, plus or minus 25 fps, with a low standard deviation of 15.3. Now I am experimenting with seating depth. I started testing the N-135 with a jump of ten thousandths, and at the end of my last session the two best settings were five thousandths into the lands, or a five thousandths jump. Go figure. 15 shots at each setting end up at an average group size difference of .03". I plan on doing more testing and chronographing in the next few weeks. But first, I need to prep 100 new cases. The original 40 are in pretty bad shape, after my beginner's abuse. Anyone want to help?

That is the results of my first year of shooting. So far, I have sent almost 1000 bullets downrange. I look back at my targets, and think about what I could do to get the groups smaller. Having a 6mm PPC built is the first thing that comes to mind, but I don't think I can do much better with a .308. My plans for the future are to make a hybrid monster. Since money is always a concern, I am going to have Mac sleeve my action, in a neat sleeve he makes himself, and put it into a Hunter Class stock. Then I'll get a Burris 6x scope. This will make a great Hunter competition rig. I will also have him chamber me another Lilja barrel, this one in 6mm Talldog. With that and a Leupold 36x, I can switch barrels and scopes and have an accurate, easier shooting gun to play around with. Unless I win the lottery, of course. . .

For getting me to this point and all that I have accomplished, I want to thank Dave Brennan and the fine staff of "expurts" who seemed to have the answers, or at least something entertaining to say, every time I opened the pages of *Precision Shooting*. Thanks also to the people at Sinclair's and the crew at Sierra Bullets. If they could, there was never an answer they didn't give me, and they weren't afraid to say "I don't know." Most of all, thanks to Mac McCluskey and Richard Nicol, for being my patient friends. Thanks, guys!

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Shooter Profile

AL CREIGHTON

by

Todd A. Kindler

Every spring and fall, there he is sitting behind a table of quality rifles at the small local semi-annual gun show. He always has an interesting varmint/target rifle or two for sale at a very fair price. If you are a varmint/target rifle shooter, your first stop once through the doors would likely be at Al's table. That's where I met Al Creighton two decades ago. Like I said, Al's table always has something interesting for the serious precision shooter. I remember buying a Marlin-Sako Model 322 in 222 Remington that was in pristine condition, just like the day it left the factory. Clean as a pin, with its Micro-Groove barrel and rough finished walnut stock. I'll never forget the fun I had for a few years with that rifle. That gun just plain *shot*. I still have a couple of photos of me at the bench, holding a bug-hole target. But the real deal was meeting Al.

Al enjoys rifles and all that goes with it, but Al enjoys people and friendships even more. From the first few meetings in front of his show table, to many memorable afternoons at his home with his gracious wife, Pearl, Al would answer (and still does) my many questions and help me in any way he could. That comes with the gun, at no extra charge.

It didn't take too many visits for me to realize that Al Creighton was one special guy. He has lived and continues to live even today one very exciting and event filled life that some of us could only dream of.

Al was born in 1910 in a home built by his grandfather in 1877 on a small family farm. In 1936, shortly after Al and Pearl were married, they built (by hand) a small white house and have lived there ever since. He continues working the small dairy farm and eventually started an orchard as well. Al hand planted the orchard on strip soil, and Al hauled buckets and buckets of water to that strip soil in the early tough, drought years. The conservation agent practically laughed in Al's face when he saw the strip land orchard. But Al had the last laugh, when the same agent stepped off the bus years later with a group of agriculture experts trying to figure out how this poor strip soil could grow such fine apples and peaches. They came to the conclusion that the odd mineral content at the soil's surface from the strip mining years before is what gave the fruit outstanding color and flavor. Al didn't know about that, but when the apples and peaches were in season cars would be backed up to the highway waiting their turn to make their purchases.

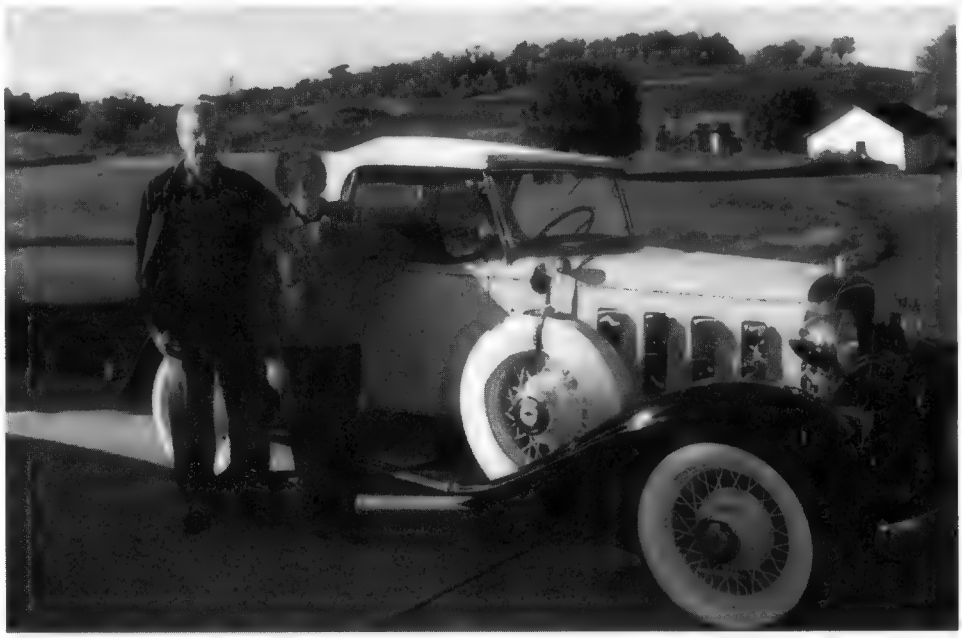
In November 1957 Al was appointed Township Trustee, and recalls shoveling out township roadways by hand in the winter, when he was paid just $3 a day for his trustee duties! They also had charge of cemeteries, which meant that they dug the graves by hand. Al's political career included more than 20 years as a Township Trustee and six years as a County Commissioner. Besides his eventful working life, Al has had an interest in rifles as long as he can remember.

It all started when he was barely old enough to hold a rifle; he would go hunting on the family farm, carrying a gun with no ammunition. This interest just intensified, and Al ended up shooting competitively for 30 years, setting two benchrest world records and winning a National Championship while he was at it.

The stories surrounding these 30 years of shooting are really what's so fascinating. Al was in it from almost the beginning of organized benchrest shooting in the late forties early fifties, and competed into the modern era of the short, fat case designs and synthetic stocks. Al remembers driving over to Dubois, Pennsylvania

Continued on next page

Al loves to head off to a parade or car show.



Al and Pearl with one of their Roadsters.

AL CREIGHTON

Continued

in the late 40's and seeing shooters using Winchester High Walls, Mausers and a few Springfield actions. He saw his first Charles Hart barrel at Reed's Run Range. Back then they "tuned those Mausers up until they shot... with paper shims under the front of the barrel".

It didn't take Al very long to get his name in the record books, and when he did, it was a biggie.

In September 4-5, 1953 Al won the Nationals at Johnstown, NY and became the National Benchrest Champion of 1953. In a letter from the Office of the Publisher of Field & Stream dated December 7, 1953 states:

"It is with great personal pleasure that on behalf of FIELD & STREAM I award you the Field & Stream Trophy for the ultimate in rifle accuracy and congratulate you on being National Benchrest Champion of 1953. Your performance at the Johnstown Shoot, the remarkable average of .529 inches for the five 10-shot groups at 100 yards, and 1.1668 at 200 yards, represents the type of rifle shooting accuracy for which rifleman have long striven, and I doubt it will soon be surpassed."

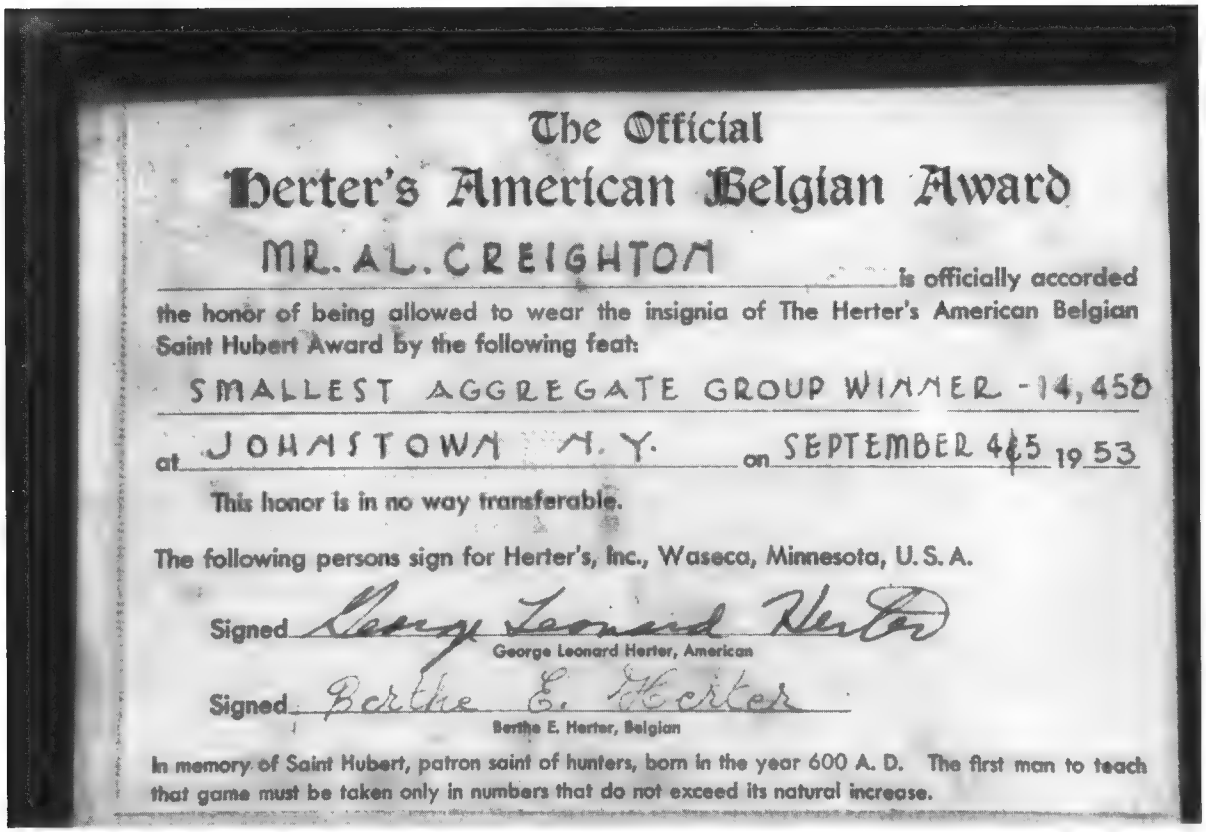
I asked Al for a few details of that match and what cartridge and rifle he used. He recalled that it took him 8 hours to drive there. He used his 219 Donaldson Wasp with only 19 gr. IMR 4227, 51 grain bullets that he made himself out of B & A dies with Kampen jackets and Winchester 115 primers. The rifle used a Mauser action, Owens laminated stock, Canjar set trigger, smithed by C.C. Johnson, and stocked by George Zimmer. One of his neat comments was that Harvey Donaldson was present when he wasn't flying around in his Corvette and told Al he was happy he had won (using a 219 Donaldson Wasp of course!).

Al likes to worry the woodchucks and crows on his farm. Here he is with his Kimber 17 Remington.

A very special belt buckle Al won in 1956.

Al also received the then prestigious Herters American-Belgian Award (well, Herters told us it was prestigious; who were we to doubt their word?) for the smallest grand aggregate winner at Johnstown, New York in September 4-5, 1953.

Al's next achievement was a single group World Record on September 17, 1954 at Reed's Run Range in Augusta,



The Official
Herter's American Belgian Award

MR. AL. CREIGHTON is officially accorded the honor of being allowed to wear the insignia of The Herter's American Belgian Saint Hubert Award by the following feat:

SMALLEST AGGREGATE GROUP WINNER - 14,450

at JOHNSTOWN N. Y. on SEPTEMBER 4&5 1953

This honor is in no way transferable.

The following persons sign for Herter's, Inc., Waseca, Minnesota, U.S.A.

Signed George Leonard Herter
George Leonard Herter, American

Signed Berthe E. Herter
Berthe E. Herter, Belgian

In memory of Saint Hubert, patron saint of hunters, born in the year 600 A. D. The first man to teach that game must be taken only in numbers that do not exceed its natural increase.

This prestigious award was only won by two people, Al Creighton and Mike Walker.

Ohio. The 10 shot 100 yard group measured .2598 and was officially measured and signed by J.F. Brandt of Baush & Lomb. The official letter of recommendation of certificate from the NBRSA Judging Committee was signed by a couple of heavy hitters with names like Colonel Townsend Whelen and Warren Page. This record beat the previous co-record of Crawford Hollidge and Mike Walker of .2677 inch.

Al's rifle that day was his .219 Wasp, Mauser action, Douglas barrel, and Canjar trigger. The scope was a Unertl 20x. The gun weight was 19 pounds, and the barrel had been shot in excess of 4200 rounds. Just prior to this match Al had C.C. Johnson rechamber the barrel after removing one inch from the breech end.

Al's notes of that day show that both Taylor and Robbins were present and as usual Mrs. Brown had prepared great food. But there were many fond memories from shooting at Reed's Run Range for both Al and his wife, Pearl. The best one Al told Linda and me as we talked one cold evening before I wrote this article. It seems that years back Reed's Run Range held a few night shoots. Sometimes the shooting, good food and friendship would carry on into the better part of the night. One particular shoot ended up early in the morning as the sun was starting to come up. Al and Pearl quickly loaded up and headed home across curvy, old Rt. 171. Al was really moving through these rolling hills in farm country (it is still that way today) because the cows needed to be milked and the milk needed to be cooled before the milk truck showed up. Flying along, Al crested a steep hill with a barn on one side and a house on another... and there were the farmer's chickens... smack in the middle of the road. Al said when he looked back in the mirror it looked like one of those old gangster movies with chickens and feathers going everywhere. A few days later a distinctly rank odor was found to be coming from the car. Looking underneath Al found a (very deceased) chicken wedged in the frame of the car!

The second World Record for Al came at Reed's Run Rifle Range on July 20, 1957. Al fired 5-10 shot groups at 100 yards for an aggregate of .3105, which surpassed Ferris Pindell's record of .3141 established at Terre Haute, Indiana on July 1, 1956.

With two world records and a National Championship under his belt you would think that is what Al would choose to talk about, but much more, it's the memories. Memories of the people, memories of the places, memories of the funny and sometimes unfortunate things that happened along the way that Al enjoys the most.

Even today, Al continues to worry a few chucks and crows with his Kimber Varmint in 17 Remington. He also has a passion for antique cars. His collection consists of a 1931 Roadster, a 1932 Roadster, a 1941 Convertible, a 1941 Deluxe Sedan and a 1957 two door hard top — all Chevrolets.

An evening with Al and Pearl is a magic moment, of the past, present and Al's enthusiasm for the future. Al is a real life champion!

A special thanks to Neal Waltz for the fine photography (all photos are to his credit).

ANALYZING METALLIC SIGHTS

by

Bill Bartram

The pages of *PRECISION SHOOTING* are jampacked each month with experiments, how-to articles and well thought theories, written by knowledgeable people with vast interests and experience. I'm about to change all that.

The majority of our readers are scope users. However, there are sufficient numbers of articles about rifle sports that utilize metallic sights, which clearly shows there's a broad spectrum of interest in all manner of serious shooting sports.

I had already started this article prior to receiving my copy of the February '95 issue of *PRECISION SHOOTING*. The articles on the Palma Team and equipment, by Dennis Flaharty, were of real interest.

I phoned Al Warner, armorer for the '95 Palma Team, for his opinion and answers to a few questions that came to mind. Obviously the mechanical ability of metallic sights is crucial on Palma rifles. The shooters are depending on them for targets as far away as 1000 yards. Al Warner manufactures the rear sight (Warner #2) used on the Palma Team rifles, utilizing a sight radius in the neighborhood of 34-1/2 inches. At the 1000 yard target each click represents 2.1738783 inches point of bullet impact change.

The subject matter of this article may not be earth shaking to the elitist long range rifle shooter who must compete with metallic sights. He either fully uses the theory behind this article or he has other methods by which to compensate. The thought behind my article is to perhaps help the shooter who is in the earlier stages of a competition shooting career. The subject is not necessarily directed towards Palma shooting; it pertains to any metallic sights and targets at any distance.

Understanding the mathematical theory and how to make it work can be of value. It can help you to make more intelligent decisions on how fine the click movement must be for your needs with your particular gun. It will also allow you to check out some highly regarded sights for their true value. (Some older sights have reputations that were built on rather close distance shooting. When adapted to longer distance shooting their usefulness can be disappointing.)

Before I get into the meat of the story, I'd like to paint a scenario to show how the subject can have some merit. You're on the firing line, shooting in competition, and the first shot goes low of the center of the target by about an inch. Now you're faced with the basic question. How many clicks of elevation do you crank in to correct the problem? Regardless of whether you're competing with handgun or rifle, if you're using metallic sights you have faced this problem, and any degree of error will cost you points.

If you really know your gun well, this isn't an unrealistic situation. Nor is it a particularly bad one in which to be, but it can be a devastating situation if you're unsure and must play guessing games.

When you purchased your gun you undoubtedly spent a considerable amount of time doing load development work and made a bunch of trips to the range for accuracy testing. The test sessions and the practice time soon brought out the pluses and the minuses of the gun. Adjusting to the pluses is easy, but you just deal with the negatives. So now begin the many trips to your favorite gunsmith.

If you're a serious competitor, you're willing to spend whatever is necessary for the gunsmith to bring out the very best potential the gun has to offer. That can start out with a bit of trigger work, rebedding the receiver, blueprinting the action and perhaps even going so far as installing a new barrel and possibly a new stock. However, the work shouldn't stop yet. I would also recommend blueprinting the rear sight. I won't bother going into any detail in this area as there have been some very good articles on this subject in past issues of *PRECISION SHOOTING* by more knowledgeable people than I.

The subject of this article is how to evaluate and analyze your metallic sights and to better understand their capabilities when you make adjustments for elevation and windage. How much will each click change the point of bullet impact at the target?

There undoubtedly are competitors who can, and do, win matches while not actually understanding exactly what happens, or what can be expected, when adding or subtracting a click or two of sight adjustment. Just as a passenger in an airplane really doesn't need to understand how an aircraft can fly. But as a passenger, I'd certainly prefer that the pilot understood aerodynamics and knows exactly why it isn't a good idea to allow ice to form on the wings of the airplane.

The competitor I mentioned has probably had years of experience with his gun, or a similar one, and has learned what it will usually do when the sights are adjusted a bit. For those who are not quite so experienced, or even the experienced shooters with new guns, perhaps I can remind you of a shortcut to success; a mathematical method to determine how much each sight click moves the bullet impact.

The method isn't normally used to determine how many clicks are needed to change from one target distance to another. As a competitor you're supposed to know what it takes to get the bullets on paper. It's the fine tuning that's important; knowing exactly how many clicks to add in to move the bullet hits where you want them. That's where the system is of real value.

For the shooter who served as the example in the early part of this article, wouldn't it have been nice to know that moving two elevation clicks would move the bullet point of impact exactly 1.1 inch? The real point is, why would you want to shoot in competition and not try to find out how much the bullet hits are influenced by the sight clicks? Why so much effort to make the gun shoot well and then pay very little attention to the aiming device?

Obviously you don't need to know what every click of the sight will do. Usually, knowing the impact change for a half dozen or so, on either side of the normal setting for that distance, is all that's needed. The number is somewhat dictated by the size and the distance of the target.

Secure the gun, or at the very least the complete rear sight, in a vice and set up a dial indicator to measure the amount of movement of the rear blade (or aperture). I prefer a dial face large enough for easy reading and capable of measuring in half thousandths of an inch increments.

While conducting the measuring session, I'd suggest rechecking each click movement at least twice to determine repeatability. I'd also check measure-

ments in both directions (up and down for elevation clicks). Don't be surprised if they measure differently. Write down all the measurements for future use.

The next area of concentration is to measure the sight radius of the gun, which is what you see when you look down through the sights. Measure from the back edge of the front sight to the rearmost surface of the rear sight. Measurement within 1/16 inch will serve the purpose.

From this point on everything is simple math. We need to establish a factor to work with and this is done by dividing the sight radius distance into the number of inches it is to the target. The following numbers may be of some use: 1 yd. = 36 in.; 50 yds. = 1800 in.; 100 yds. = 3600 in.; 1 meter = 39.37 in.; 50 meters = 1968 in.; 100 meters = 3937 in.

To keep things simple we'll make up some measurements for a hypothetical rifle: Sight radius = 24-1/4 inches and the rear sight movement is .0035, .004, .003, .0045, .003 and .0035.

Dividing the 24.25 inch sight radius into the 3600 inch target distance we come up with a factor of 148.45. We multiply the factor by the various sight movements to determine the bullet change of impact at the target. These figures turn out to be: .52, .59, .46, .67, .46 and .52 of an inch.

Averaging things out, the sight movement is .0036 inch and the bullet impact change is .53 inch. Averaging is probably the way to go if you have a sight of even reasonable quality. The clicks will probably be fairly uniform. Impact changes of 1/10 of an inch, or so, have little bearing. The real point is that you have a simple method of analysis that might be of assistance in improving your scores. And you have a bit more knowledge and confidence in the equipment you use for competition.

While measuring the sight movement, it's an ideal time to check the sight clicks for backlash. Backlash is the result of tolerance and slop within the mechanism of the sight. Move the sight two clicks in the same direction and them move it back one click. If that one click movement is a different measurement than when you only moved one click, you've found backlash.

I'll give you an example. You raise the sight one click and it measures 4-1/2 thousandths of an inch higher. Return the sight to the original setting. This time you raise the sight two clicks and back down one click. Now the dial indicator shows that one click elevation raised the sight 4 thousandths of an inch. You have a half thousandths inch backlash at that click setting.

You will probably need to measure backlash several times (windage, too) to firmly establish the best method to control backlash as much as possible. You may find it necessary to add two or three extra clicks and back them out to do the best job. Backlash is almost always present in the sight. It's up to you to identify how much and how to minimize the problem.

I learned a lesson about open sights years ago because of a problem I encountered. I was participating in a match with a new handgun and had only managed to obtain rough sight settings for the necessary target distances the day before the match. The weather was considerably different than on the day of the match. I was fine on the nearest targets and confidently adjusted the sight for the next distance. On the first shot my spotter called the shot as being an inch low. I raised the sight a click and the next shot went even lower than the first. I believed my spotter, but I couldn't figure out what was going on. I added another click and no change of impact; added one more with still no change. One more click was dialed in and this time the bullet went over the top,

At home I set up my dial indicator and measured click changes for the first time in my life. It was also the very last time I assumed the manufacturer actually built sights that did what they said they would do. That particular sight actually did move in a downward direction when I moved the elevation screw upward. It made absolutely no movement at all for the next two click adjustments. The last click allowed more than seven times the movement it was supposed to. I don't know what was wrong with that sight, but it was soon replaced. That was the very last time I've ever neglected to check out open sights with a dial indicator.

I once watched a friend in a shoot-off of small targets at 200 meters. His elevation was correct but he shot varying degrees to the left of the targets. He is a firm believer in using Kentucky windage. I knew that, but I still couldn't resist asking him why he didn't adjust his sights. He replied, "I'd rather eat worms than mess around with the windage screw."

I'm a firm believer that the mathematical analysis of metallic sights works well, but I've talked with a few people who said it didn't work on their guns. Close examination brought out the probability that the measurements or math application wasn't correct, or those shooters expected the system to change the weather conditions for them. I've never found that the formula will make the wind stop blowing, but if I ever do, I'll most definitely write an article about it.

As a point of interest, I decided to have some fun applying the formula to the #2 Warner rear sight. The sight radius is 34.5 inches, target distance of 1000 yards and bullet impact change of 2.1738783 inches. Dividing the sight radius (34.5 inches) into the target distance (36,000 inches) equals a factor of 1043.4783.

If we want to determine how much actual movement the Warner #2 rear sight provides per click change, it's easy to do so. Dividing the factor (1043.4783) into the known bullet impact change at 1,000 yards, one click makes 2.1738783 inches, and we come up with a figure of .0020833 actual sight movement per click. I realize it's not practical to run the figures out to the ten millionth of an inch when the target is 1,000 yards away. I'm just demonstrating that the theory can be quite precise.

If you have followed along with your calculator, you've undoubtedly already discovered the Warner #2 sight is going to be difficult to beat. It's darn good. You've also discovered the formula to analyze metallic sights works rather well, too.

The trick is to understand your needs for your particular gun, and for your chosen shooting sport, then to have the ability to recognize the metallic sight that will match those needs. You'll not have to remain dependent on unknowingly misleading information about sight quality. You have the tools to do your own analysis and to make your own judgements.

PRECISION SHOOTING INDEX

We have heard on a number of recent occasions a wish for an abbreviated PS Index, confined to more recent times, and at a lower price. In response to these requests we now have available an index of major articles that have appeared in Precision Shooting starting with the January, 1990 issue. The new Index covers some 25 pages at present time, and is completely up-to-date through the current issue, and will be updated each month.

The price for the abbreviated PS Index is $8.00, plus $1.00 S&H. Order from . . . Precision Shooting, 222 McKee Street, Manchester, Connecticut 06040.
Phone orders or fax orders, using Master Card or Visa, accepted at (860) 645-8776 (phone) or (860) 643-8215 (fax) during normal office hours.

BRITANNIA STILL RULES THE WAVES

(Jack Brogden)

Dear David,

Put another log on the fire, pull a chair up and let me tell you a shootin' story. (Somebody get the ale in, this is gonna be thirsty work.)

Harkin' back to the halcyon days of yesteryear, or to be more precise, late '71, early '72, a friend of mine, one D.J. Taylor, (hereinafter referred to as "Deej",) got this crazy idea.

Why don't we challenge the riflemen of America to a match, a combat to the death of every man-jack?" he asked, with a mad glint in his eye. (He does an excellent imitation of Long John Silver, incidentally.)

"Steady on, Deej, think of the political ramifications," I cautioned, "it's only a sport, bear in mind."

Sufficiently calmed, he was then in a suitable state to flesh out the bones of his idea. It was decided that a prerequisite item to make the whole venture a success was funds, so an agenda was drawn up to make them available.

(This ale has got a lot of froth on it....)

What we needed was a strategy and a title and a marketing plan. "What about a team, to be known as "The Combined Roses" funded by the associations of Lancashire, (The Red Rose,) and Yorkshire, (The White Rose,) said Deej. It was more a statement than a question.

"Brilliant" said I. "We now have to convince those august bodies to think on the same lines and get them to relinquish their grip on the spondulicks." That we were successful is now a matter for the historians.

(I'm sure we've been given short measure....)

The Grand Plan was modified somewhat. Instead of the marshalled might of the National Rifle Association of America, we decided to "target", (forgive the pun,) the Bear of California.

(Slurp....)

So, we needed to do this properly. Perhaps it was fate that brought Deej and myself together for this very moment, for him to be rubbing shoulders with the best goddam signwriter in the whole North-West and a modest one to boot.

(Gerra 'nother pint in....)

I was charged with the task of producing a parchment scroll, on which the archaically-worded would be scribed. Whilst I rushed off to the nearest Arts and Crafts shop to acquire pens, Indian Ink, etc., Deej made a bee-line for Wilkinson Sword and cajoled them into presenting a broad-sword, suitably mounted on a teak plinth. It was a five feet long instrument.

(Hic....)

Our marketing story-board was Excalibur, Camelot, King Arthur and The Round Table and The War of the Roses. It mattered little if these events shared the same time-span of history, we were out to impress in as theatrical manner as possible. After all, the scroll was addressed to the desk of Ronald Reagan.

(Siddown, it's my round....)

The drawing-board was brought into commission and the artwork begun. After a bit of practise, I found that the hand had lost none of its old cunning and Olde English type-face flowed from the broad tip of that pen. Illuminated capitals, enhanced with 23 carat Gold-Leaf and brilliant colours, served as leaders into each paragraph, the whole embellished with highly decorative rules completed the document. The edges were scalloped and torn and a cigarette lighter was judiciously applied to heighten the illusion of age.

(Eeeeh, lad, this is a reet grand drop o' stuff.) Translation; "This, sir, is a very good drink of ale."

During the long hours of production, I was transported to the bowels of a monastery and there, shrouded in cowl and rude habit, scant protection against the dank atmosphere, I exercised my craft.

(Burp....)

It was with a degree of pride that my creation was displayed at the next Committee Meeting and I received their plaudits with a certain degree of equanamity. Unlike, as I recall, Deej. He had, by that time, collected The Sword from Wilkinson's and he stood in the middle of that room, wielding that magnificent implement like a whirling dervish. Sir Lancelot and The Quest for The Holy Grail.

(Wink at the barmaid with the big pectorals, she'll fill 'em up properly....)

The more imaginative of us could hear the clank of armour and the swish of chain-mail, but the more stoic just thought he was nuts.

The parchment was carried off to the offices of the Duchy of Lancaster and the Yorkshire equivalent, where official seals, all red wax and red tape were affixed, the final touch of authenticity.

(Have you noticed the sediment in this ale?...)

It was sent, together with a photograph of the Trophy to Ron and probably resides to this day in the California State Archives.

As we expected, the challenge was accepted and one Jim Whitney, at that time boss-man of the US Palma team as well, was given the task of putting a team together. We had decided to hold the Match just before the Imperial Meeting at Bisley, so that the trip would be doubley worthwhile for those intending to come over.

More approaches were made to industry for sponsorship and a local brewery were overly-indulgent in their benevolence. A butcher of our acquaintance provided a whole pig, a spit and the expertise to roast it over an open fire, an all-day operation.

(If I have any more of this ale, I'm gonna be sick....)

So, the great day arrived. To the tune of "Over there, over there," the Yanks arrived. One of 'em had to be at least eighty inches tall and 260 lbs. Our Chairman, also of gargantuan stature, shook hands with him and we got the local paper to photograph the event and at our instigation, captioned it, "Godzilla meats King Kong."

We, the Committee, decided that win or lose, California should take the Sword back home with them. It would be an invaluable aid to promote interest in the event. For their part, California brought a musket of certain antiquity with them and presented it to our Captain at the dinner which culminated the two-day event.

(This ale is definitely "off" – I think I'll go on to whisky....)

The Match comprised of two sighters and ten for score at 300/500 and 600 yds and it soon became apparent that there were experts among them, like Bob Jensen, f'rinstance. Some were less skilled, but it didn't matter, for we were all enjoying the experience.

Because I had a loose association with a major drinks company, (Editor: I love that line! Many of my best friends have "loose associations with major drinks companies...") (I have done various jobs for them,) it was decided that I must be able to connect the CO2 cylinders up to the beer kegs. (It's surprising how minds work.) Only when I succeeded in directing a high-pressure jet of beer onto the ceiling, that my claim to ignorance of such technicalities was taken seriously.

Subsequent events, wholly of a social nature, became lost in the mist of time.... even the day after, but I can vaguely remember thinking, full of beer and boar, that the Romans had trodden a similar path.

Political intrigue at this end, with the Yorkshire contingent taking control, caused me to lose touch with later developments. The original idea was that the Match should take place annually, the venue alternating between countries. P'raps somebody out there can fill in the missing detail?

(No, Dave, you can't drive home in that state....)

Yours sincerely,
Jack Brogden
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WWII: A TRIBUTE TO A GENERATION

by

Roger Clouser

The recent news coverage of the 50th anniversary of the end of World War II got me thinking about the generation that won that war, and how much I owed it. I certainly have a great deal of admiration for them, those who actually did the fighting and those who helped at home alike. One of the things so impressive about that generation is that the war effort put the majority of Americans into one of those two groups. It was a first class collective effort when the world really needed one. That was a tough war. But it had clarity and was met by a generation of Americans that saw clearly what had to be done and did it. The nation really appreciates that. You of that generation should be very proud.

How else could I be taking a break from measuring bullet base runout on a batch of match grade cast bullets that I would like to shoot into one hole at 100 yards? Such a pursuit is a most fortunate freedom preserved by that generation — a generation that knew how to work hard and pull together, not to mention run into a hail of machine gun fire when necessary. The news coverage of the anniversary of the Normandy Invasion with films of our troops storming the German-held beaches showed this was a generation that knew when it was time to make big sacrifices. Watching the various WWII anniversary films being aired recently, the Battle of the Bulge, the desert war in Africa, the war in the Pacific, the final push through Europe, one cannot help but admire and be impressed by a generation that sacrificed so much and worked so hard. And they did all of this after suffering through many years of the Great Depression. Now **that** is a generation.

This was a generation that designed and built some pretty fine machinery and knew how to use it. Cooperatively developed with the Brits, our radar was first rate. The deuce and a half, Jeep, amphibious landing craft, the P-51 Mustang, the Grumman F6F Hellcat and later models of the P-38 were certainly standout machines of that war. And of course there was the M1 Garand, a piece well ahead of its time in firepower during WWII but still capable of enough accuracy to be effective to 800 yards (Carter, 1951). Here is a rifle we are still squeezing for accuracy gains, still writing up in Precision Shooting and still using in competition.

Roy Clouser, the author's father.

The legacy of such fine machinery allows us to be in the enviable position of trying to figure out how to get our bench guns to aggregate in the .1"'s instead of the .2"'s. I suspect that most Precision Shooting readers are not just interested in the extremes of rifle accuracy, but also have an overall appreciation of fine machinery in general. I would rate them as fine machinery junkies and include myself in that category. Once a person is exposed to precision machinery and works with it a while, it is usually difficult to be content with the second rate varieties. The first reloader I ever met, at age 12, was a retired machinist. I now realize that was no accident as machinists and machinery junkies have been and still are by far the largest contributors to the cutting edge of knowledge in firearm accuracy.

Appreciation for such machinery is not entirely passed on from one generation to the next by merely transferring the ownership of the machine. Much of this appreciation is transferred in attitude. As a kid, I was aware that my father, Roy, owned a classic Winchester 52, but his serious attitude toward shooting didn't take its full effect until I was about age 13, while blasting away at tin cans with two of my brothers in a gravel pit. Roy watched silently for some time, and then walked over to us at a break in the action and handed me a box of .22 ammo. "Why don't you just take this," he said quietly and with no emotion, "and throw it in the gravel pit?" We laughed like hyenas at the comment and deadpan presentation, and told him it was much more fun running the rounds through our Model 75 Winchesters and continued with our blasting. Even though we thought the comment quite funny, none of us missed his point that we were not engaged in any semblance of precision accuracy and therefore were obviously wasting the ammunition. And that was difficult to ignore coming from a man who had worked for $18 a week through the Great Depression and wore out the bore of a star gauged M1903A1 Springfield while on a military rifle team. These are the ways attitudes and values are passed from one generation to the next, and I cherish all that I learned and am still learning from the generation that fought WWII.

It was not only the appreciation of fine machinery that was passed on. That generation faced challenges that gave them an ethic for hard work, a sense of purpose, an appreciation of frugality and a tough, determined commitment to do what had to be done. Some young people today have difficulty finding a sense of purpose sufficient to get them through enough schooling and training to make a contribution to our nation. They frequently opt to drop out and perhaps face the problem later. The generation that won WWII had no such luxuries; in fact for many of them it would have been a luxury to be allowed to complete their schooling. Women as well as men dropped out of school, taking menial jobs to help their families during tough economic times, and later contributed in many ways to the war effort. The ladies joined the military and entered the industrial work force in great numbers. They raised families, scrimped and saved, planted victory gardens and made major contributions in the transfer of values to the post-war generation.

As a member of that post-war generation, I feel lucky to have been brought up by a generation that survived and learned how to live and improvise under tough conditions. As a kid, if I needed a spare nut or screw to fix a bike, Roy would send me to dig through an ancient metal bread box filled with a nasty assortment of hardware. Strangely, that ugly thing almost always coughed up with the needed item. After years of digging through it, we brothers laughed about that silly box, joking that any small part needed was in there, somewhere, if you were willing to spend the time searching for it. There were also collections of wire, wood, metal, string, almost anything, scattered and piled throughout the garage. The place was a living breathing monster that had to be tamed and pushed back occasionally so it would not overflow its boundaries. But when Roy could find an item that was needed, the look on his face as he handed it to me said it all. His frugality had been rewarded, justified and vindicated from the heat he took from the family for maintaining the garage monster. He knew at that moment his garage policy was the right choice. He called this at a time and still refers to this frugality as a "depression mentality," since one never knew if something would be needed later on, and going to the store was out of the question. Growing up in a milieu where one searched through the "bread box" and the rest of the garage rather than simply going out and buying what was needed at the hardware store was annoying at the time, but in hindsight was clearly an advantage. In the absence of simply buying everything, I found myself scheming, repairing, designing, and fabricating things as a kid, and continue to do so today. Ideally I would have a machine shop in my basement, and my guess is that many Precision Shooting readers feel the same way. It is, after all, new ideas on the cutting edge of technology that bring us together. Personally, I feel lucky to have grown up under this "depression mentality" and its inspiration for innovation.

With an average credit card debt of $1,700, one of the lowest savings rate of industrialized nations and many Americans driving cars costing far more than our annual salaries, post-WWII generations did not readily adopt the concept of frugality. Report after report in the national news warns that the Baby Boomer generation is not saving or preparing for their retirement and that they face big financial problems in the future. Of course post-war working America enjoyed the largest economic expansion ever experienced by this nation, but after what the WWII generation endured, it was certainly well earned. Living through the Depression taught that generation the value of saving and living within their means, a set of values which has served them well for their retirement today. My guess is that many Precision Shooting readers, regardless of their generation, are at least moderately frugal and dismayed at waste. As precision machinery junkies, we are intensely engaged in high performance, and waste is usually contradictory to such interests. I bet many of us have scrap bins of brass, steel, wood, plastic and other goodies that are just too nice to throw away and besides, we might need them some day. This is not related only to frugality, but is also a necessity for people who repair and make things and are constantly tweaking machines for higher performance.

The soldiers who won WWII came back from that war, bought three bedroom, one bath slab ranchers, started families and worked in decent jobs. And even after experiencing the horrors of war, they maintained their appreciation for firearms. Perhaps some first found that appreciation through their military experience. But amazingly enough, they separated the killing from the machines, retained an appreciation for their beauty, and with those machines found scores of sporting, competition and recreational pursuits. They had fun with firearms. They sporterized them, modified them and continued to press for gains in extreme accuracy. I do not know if this was a difficult transition, but it certainly seems a sophisticated one.

In fact, that generation seemed transformed by their war experience into a group of people with a great deal of internal confidence and cool. To me, they never seemed to wear the war on their sleeve but rather internalized its lessons into an inner personal strength. It probably helped a great deal that the nation felt grateful toward and venerated returning veterans, an appreciation not universally bestowed on the military of later wars. But even so, this internal confidence was present in veterans and non-veterans alike and provided solid role models for the next generations. As parents, grandparents and great-grandparents, this generation made a host of contributions on a personal and spiritual level far beyond simply surviving that nasty war. We thank you of that generation for that strength.

So I propose a toast to the generation that won WWII. Here's to Bill Kennard who parachuted into Germany with a Thompson strapped to his chest. Here's to Paul McMullen who returned to the Battle of the Bulge after being hospitalized twice in that fighting. And here's to all of the men and women who stayed home and toughed it out, working in factories, raising families and doing their part in helping get our nation through those arduous times. We of the following generations thank you and salute you.

Source Cited

Carter, Ross S., *Those Devils in Baggy Pants,* Appleton, Century, Crofts, 1951.

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SOME ADDITIONAL THOUGHTS ON A MORE PERFECT BEDDING JOB

by

Ken Erickson

After reading Frank Randall's article on glass bedding in the July 1994 issue, I would like to offer some additional comments and suggestions that I have never seen mentioned before. Hopefully it will make the job easier and more foolproof.

I first saw the procedure called "plastic bedding" described in the April, 1935 issue of the "American Rifleman". The writer had an '03 Springfield which shot all over the place after a restocking job. The bedding material used was good old Plastic Wood — Alvin Linden called it the "Woodbutchers Friend". Later, another reader used Durham's Rock Hard Water Putty for the same purpose. Both claimed much improved results from the new rebedding jobs. It was called a "molded fit" — and so it was.

Sometime around 1950, Herter's came out with their "glass bedding" kits, which promised a perfect (!!!) bedding job with a resulting increase in accuracy. This was a polyester resin, thickened and strengthened with chopped glass fibers for a filling material. It was hard to handle and had excessive shrinkage, but at least it was not softened by heat. Now, most, if not all of the bedding materials are some form of two-part epoxy, which have some important advantages for our purposes. All the same, I have seen some strange things used for bedding rifles, including PVC pipe compound, two-part self curing acrylic dental resin, Bondo auto body filler, and the most unusual of all, a highpower shooter friend of mine claimed he once had a rifle bedded in rubber, and that the rifle shot like a house afire. I have tried many of these and will stick to the modern ones, thank you.

Probably the most popular commonly available bedding materials in use today are the many types of Acraglas, as sold by Brownell's... Devcon (both steel and aluminum filled), and Bisonite. Although the physical properties, such as shrinkage, hardness, and resistance to deformation are very important, it is usually the handling characteristics which make them popular. If the stuff is too thin and runny, or stiff and doughy, it is almost impossible to get a nice job with it.

Acraglas Gel is very popular because it is readily available in local sporting goods stores and it handles very nicely. I like to use it for bedding hunting rifles and sporters. However, the filler used is nylon fiber and it never ever gets really hard — clippings resemble fingernail parings. They stay flexible forever, and for that reason I hesitate to use it for a hard use rifle like an over-the-course match rifle. I feel that the steel filled Acraglas would be a better choice for this application.

Devcon, both the steel and aluminum filled, are very popular and deservedly so. They are both very easy to work with, have an excellent working time, and get quite hard. Most of the highpower shooters I talk with use the Devcons, but they are somewhat harder to locate. Many machine tool houses and industrial supply companies carry the Devcon line of filled epoxies, so you might try calling one of them.

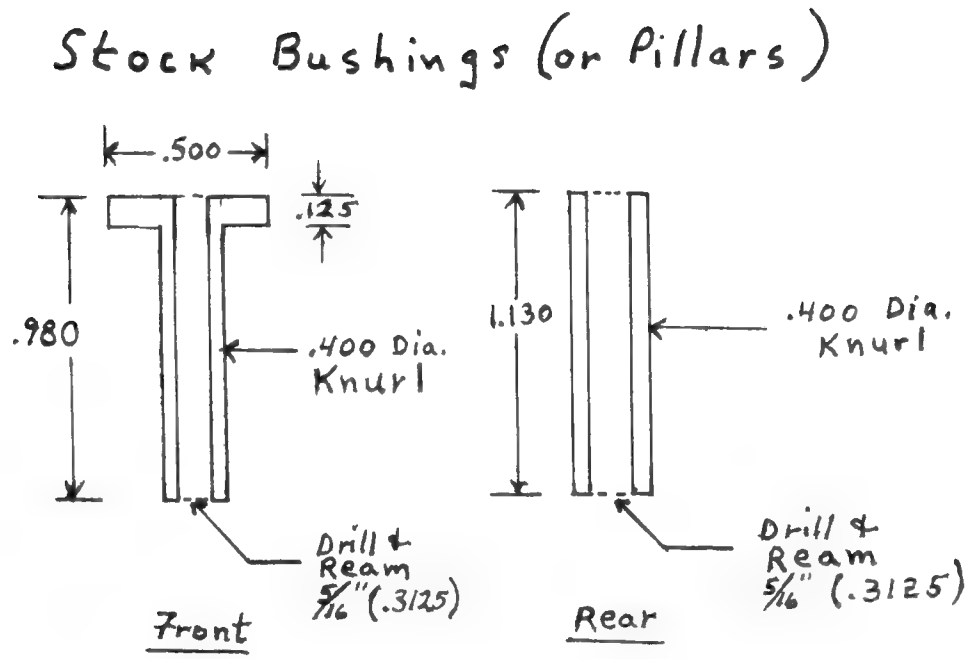
I was told by good authority, that the AMU at Fort Benning uses Bisonite exclusively... for its hardness, and reportedly zero shrinkage. It needs a filler to bring it to the proper consistency, but when it sets, it is very hard indeed. Some years ago, I had occasion to rebed a rifle for a friend who had spoiled the job. He had used Bisonite, and I think Michelangelo had an easier job carving out David out of marble than I did in removing the stuff.

Probably the most common and annoying flaw that can occur when bedding, are bubbles, both large and small. They may or may not affect the performance of the rifle, but they look terrible and are always embarrassing to see — especially if you have done the job for a friend; or worse... for pay. They may be almost always avoided by observing a few principles of how material flows. The biggest offenders seem to be the inside angles in front of, and behind the recoil lug. When applying the bedding material into the stock, save a small amount to put in those angles on the receiver. This will completely avoid trapping air bubbles. In addition, I always put a paint coat of bedding material on the rest of the receiver itself, where it fits into the stock. It is important to pile up a ridge of soft bedding material in the very center of the inletting, so that, as the metal parts are lowered into the stock, the ridge will be the first thing contacted, and the material will flow outward and not trap air bubbles. This is really very effective, and will usually give you a perfect, flawless bedding job that you will be proud to show your friend, or customer.

If you have access to a lathe (or a friend with a lathe) you can make the two pillar bedding screws illustrated, together with the pillars required. These have a couple of important advantages and will make the pillar bedding job much easier and foolproof. One, they will automatically establish proper guard screw clearance. Secondly, they will permit you to rebed the rifle at a later date without the strong tendency for the barrel and action moving forward in the stock.

The barrel and action, plus the trigger guard, should be carefully and well bedded in the wood or fiberglass stock. It is important that the metal parts not rattle around or otherwise move in the stock when the regular inletting guide pins are removed. At this point, the front guard screw hole is drilled out with a 5/8" drill, and the rear hole is drilled out with a 1/2" drill. Anything much larger and you might damage the edge of the inletting. If you do very much of this, it would be a wise move to have some drills made up with 1/4" pilots — it makes it much safer from accidental dings to the edge of the inletting. Seat the barrel and action in the stock, making certain that they are down all the way, and turn it over. Screw the special pillar bedding screws in place in the receiver, and drop the pillars down over them — you should hear metal-to-metal contact. If all is well, you are ready to epoxy the pillars in place. Thoroughly coat the outside of the special screws with Johnson's or Bruce paste wax, and using a Q tip, coat the inside of the pillars as well. The bottom of the receiver behind the recoil lug, the bottom of the rear tang, and the trigger guard should also have a couple of coats of wax.

The waxed barrel and action are placed in the stock and seated to place; double check this several times during the procedure, since it will be hard to remedy once the pillars are epoxied into the stock. Turn the stock upside down,



and drop the pillars down over the special guide screws, making certain you have metal-to-metal contact. Then fill in the area around the pillars with a thin runny epoxy right up to the wood level, and place the trigger guard assembly in place. I use a C-clamp with wooden blocks to hold everything together while the epoxy is hardening. Again, double check everything to make sure the metal parts are all in their proper place. Leave it to harden, upside down.

After the epoxy has set, the trigger guard assembly may be removed, and the special pillar bedding screws are unscrewed and removed. The barrel and action may now be carefully removed from the stock. Examine to make sure that the pillars are flush with the stock wood or fiberglass, if it is a fiberglass stock.

Assuming the pillars are in their proper place, you may now remove the wood where you want the bedding material to fill in. Most gunsmiths who do a lot of this bedding work feel that a fair amount of wood should be removed so that you will have a good bulk of bedding material. I try to aim for a minimum of about 3/16" to 1/4", depending on the room or space I have to work with. I also drill a flock of 1/8" spike holes, about 1/8" to 3/16" deep in the stock bedding area. No point in drilling these holes any deeper because air bubbles get trapped in the bottom anyway. Some access must be provided for the escape of excess bedding material, around the action especially. Opinions vary on this but depending on the viscosity of the material, you probably will want to leave about 1/64" to 1/32" of space — otherwise you will

Continued on next page

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SOME ADDITIONAL THOUGHTS ON A MORE PERFECT BEDDING JOB

Continued

notice the barrel sticking up in the air at the forend tip.

Before putting the separating media on the metal parts, try the barrel and action into the stock to make certain that they rest on the metal pillars. Double check that the loading port and the rear tang are at the level you want, and that everything goes to place properly. You should now be ready to use your bedding material, making sure to do the following:

1) Install the special pillar bedding screws, with plenty of separating media, and wax the inside of the metal pillars in the stock as well.
2) Fill in the angles in front and rear of the recoil lug with material.
3) Put a paint coat of material on the receiver where it goes into the stock.
4) Build up a ridge of material in the center of the inletting.

Seat the barrel and action in the stock, guided by the special pillar bedding screws, and slowly push it down to place, allowing the bedding material to flow out the escape gaps. I use a C-clamp with the lightest possible pressure, to make certain the barrel and action are all the way down. Pad the C-clamp with wood blocks to avoid marring the metal or stock. Allow to set for several days in a horizontal position. I remove the bulk of the squeezed out excess with a wooden popsicle stick.

Hopefully we now have a perfectly bedded rifle, so how do we get it out of the stock without distorting the fresh bedding, or damaging something? The first thing to do is to give the bedding screws a couple of good raps with a soft hammer on their ends. Then unscrew and remove them. For the rest, we are indebted to the NRA Gunsmithing School in Trinidad, Colorado.

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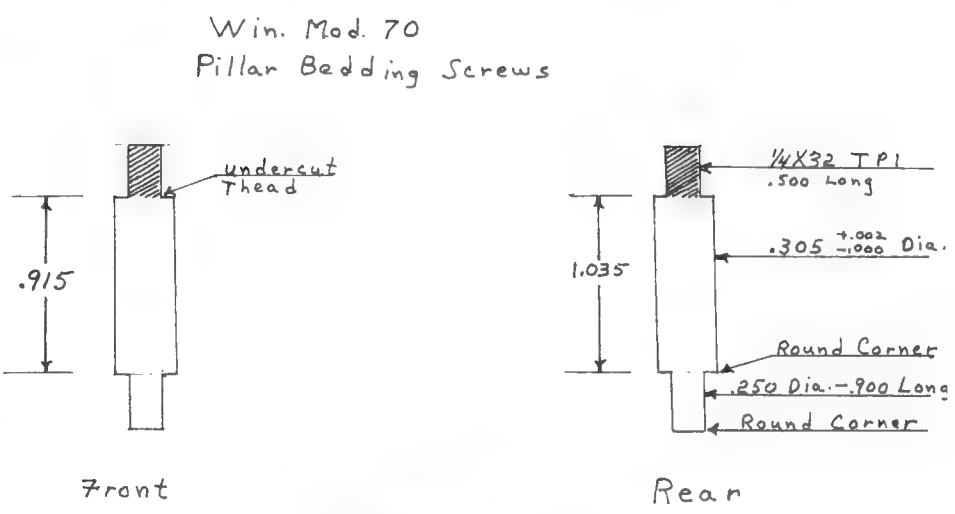

See the illustration of the action puller. To use it, place the 5/8" rod in the receiver where the bolt goes, and thread the 3/8" threaded rod into the 5/8" rod through the top of the loading port. The piece of 2" pipe is slipped over the threaded rod, and the rubber padded edges are placed over the receiver and rested on the side edges of the stock. The nut and washer are threaded on, and tightened with a small wrench. The receiver will come out of the stock perfectly straight, with no danger of distorting or breaking anything. Of course the threaded rod can only be used with actions having a loading port open on the top. For benchrest style actions, it is necessary to make a hook style replacement – see the illustration. It will be necessary to make several sets of pipes and hooks to cover all actions. When you see how slick they work, you will not begrudge the time spent to make them up.

Ken Erickson
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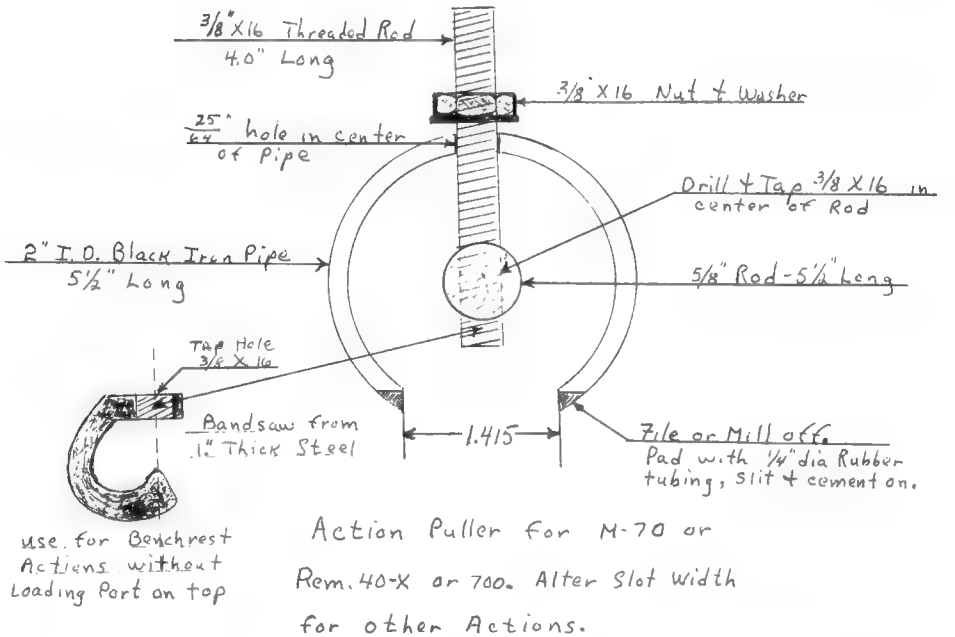
3/8"X16 Threaded Rod
4.0" Long
3/8" X16 Nut & Washer
25/64" hole in center of Pipe
Drill & Tap 3/8 X16 in center of Rod
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WHAT'S THE ULTIMATE AIM?

Could there be a better way of looking at targets?

by

Charles F. Young

When I was a little laddie bashing bunnies by the gross, my rifle was as lethal as any fictional space-age hero's death-ray. Out to 80 or 90 yards, if them bunnies were daft enough to pause for even a second, they got their termination in the form of 40 grains of Eley lead. Now then, that started in 1954 or so, and the rifle was my Father's, a single shot bolt-action Savage of significantly pre-war vintage. Shooting rabbits was a serious business in those days. Rabbits ate grass (and most other green and growing things), and they were a plague on the land. They bred like – well, like rabbits. Farmers used to organise swat-teams, and spent days on each others' fields and hills, vainly trying to exterminate the furry pests, using gas, bullets, shot, nets, dogs, ferrets, traps, and worse. There were billions of them. Ultimately, they resorted to germ warfare, introducing a disease called myxomatosis, which solved all rabbit problems for twenty years, coincidentally ruining my fun. My regular reward for my lethal efforts was a box of 50 Eley 22LRs for each 40 rabbits accounted for. One cheap-skate farmer used to palm me off with 22 Shorts! These annoyed me, because they tended to drop short at longer distances, and adjusting sights was not something I knew much about. The sights were primeval anyway. The front sight was quite a nice little black bead, but the one at the rear was akin to two bent bits of a Baked Beans can. For all I knew, they could have been just that. At that time I had never even seen a telescopic sight, so I shot on confidently, assassinating bunnies by the score. I seldom missed. This was for several reasons. One, I wanted to have as many "extra" rounds as possible left over for other fun things. Two, to further that aim, I stalked my quarry carefully, and tried to line them up in pairs. This sometimes worked, especially using solids. Three, that little rifle could shoot quite well, and so could I, because I had such faith in it. And four, only realised quite recently, the sights were attached to the barrel, especially the front one right at the muzzle. You might think that's pretty obvious, but the trouble is, it is SO obvious that the implications and potential advantages didn't dawn on me for nearly xxxty years, during which time I have fired tens of thousands of rounds using both 'scoped and iron-sighted rifles. But one thing I always pondered was why it was that simple target rifles with utterly crude metallic sights, could shoot so amazingly well, often a deal better than many rifles with fancy and expensive 'scopes.

Consider Target Rifles and Match Rifles as used with "metallic sights". Let's face it, rifles like these can shoot. Take, f'rinstance your USA Palma Match rifles. People like Nancy Tomkins (we will come back to Nancy shortly) and the US Palma Team can shoot five or six-inch groups at 1,000 yards with sights like that, which is about eatsy-peatsie with the best of the 'scoped rifles in the same calibre, 308 Win. Now, it suddenly seemed a bit strange to me, just a few years ago, that shooters with simple metal sights could frequently out-shoot others with 20-power (and more) 'scopes mounted. So, I started to think about it, and to ponder. It took a while, and so far, the best position I have reached is rather an enigma. As a result, this little piece is more of a question-posing session than anything else. What I want YOU to do, dear Reader, is to come up with the answers. I'm not smart enough for that. But here's the thinking behind where I am at now – which may be entirely up the creek, or on the brink of something interesting.

Let's consider the case of a rifle with a 'scope mounted on it. The 'scope is screwed (and glued!) to the top of the receiver. The barrel is also screwed (but hopefully **not** glued) into a big threaded hole in the front of the receiver. This is only a coincidence. My revelationary thought was this – the sight-picture would not be affected in any way if, whilst Walt Berger (for example) was in the aim, somebody unscrewed and removed his barrel! OK, so Walt would probably notice somebody stealing his best barrel from under his nose, but do you get the point? Now, consider a different scenario – bad-guy Lex Luthor sneaks up while Walt is in the aim, and loathsome Lex uses his heat-ray to make Walt's barrel white-hot right in the middle. So the barrel quietly droops by a couple of inches at the muzzle, and when Walt fires his shot, the poor bullet hits the ground a few yards in front of the gun. What difference in his aim did Walt see through the 'scope when this took place? Absolutely none – not one bit. Because the barrel of a 'scoped rifle plays no part in the sighting system. Every part of the sights-system is contained in the 'scope, which is aligned exclusively to the receiver. Even if the barrel is bent at right angles, or is completely missing, the sight-picture through the 'scope is not affected. (Moral – make sure the barrel is there before you start shooting!)

Things are not that way with metallic sights, if the front-sights are fastened to the barrel near the muzzle, which they all are. Consider the scene again – there's Nancy Tomkins in the aim, just ready to let loose at a target 1,000 yards yonder. Along comes dastardly Lex Luthor again, and zaps her barrel with the heat-ray. The barrel drops a couple of inches at the muzzle. What happens? Well, Nancy sees her front-sight drop out of view. Being a nice lady, she says, *"Oh my goodness, what happened there?"* This is why we chose Nancy for this half of the example – if it had been a MAN-shooter we used, Dave Brennan would not have been able to print his words. Men tend to utter VERY BAD WORDS at moments like these. Anyway, Nancy would certainly notice it when the barrel dropped, because of the vital fact that half of her sighting system is fastened to her barrel at the muzzle, and she would be looking right at it (through it) as it dropped.

Now that the principle has been examined and agreed (who can argue with it?), suppose we look at a much less extreme example. Suppose our 'scope shooting Walt is shooting away with nice loads, and his barrel begins to warm up a bit. There's a stiff cool breeze blowing from the right, tending to cool his barrel down on that side. So, as the left side of the barrel is warmer than the right side, the

Continued on next page

WHAT'S THE ULTIMATE AIM?

Continued

whole barrel takes a wee bitty bend towards the COOL side. Does this affect what Walt sees through his 'scope? Not one bit, so chances are, the next shot goes a teeny-weeny bitty to the right. But now we set Nancy to work with her metallic-sighted Palma rifle. Same range, same day, side-by-side with Walt. She shoots away for a while, the barrel warms up a bit, the cool breeze chills the right side of the barrel, and it bends that little bit to the right. What happens? Well now, the barrel bends for Nancy just as Walt's did, **but this time it takes the front sight with it**. Just like Walt, Nancy doesn't even notice as she lies quite motionless in the aim that her front-sight moved across to the right. Does she shoot? No way! Not till that aim is perfect she doesn't. Automatically, unconsciously, Nancy centres and perfects her aim by bringing the rifle a tiny bit to the left, and then she shoots. *"So what"*, did I hear someone say? So, with the front-sight mounted on the barrel near the muzzle, errors caused by barrel movement are largely compensated for, automatically, because the front-sight goes with the barrel, taking the aim-picture with it, thus inducing the shooter to regain the correct aim-picture by bringing the rifle away from the direction of the error as the correct aim is recovered. Now this will not completely overcome such an error, but as I see it, and as far as I have been able to think it out, it will compensate for and correct at least three-quarters of errors induced by the range of movement which might be expected in barrels which warp or bend in service, which many or most must do to some extent or another. Some I have seen move plenty. If YOU want to see what YOUR barrel can do, get your collimator handy on a windy and cool day, with a good 3 or 9 o'clock breeze. You should use an expanding pilot for your collimator (you have one of those, of course?) because them other ones can flap about quite a bit. Then (but NOT with the collimator pilot rod stuck in the bore - which has happened with HORRIBLE results) you set about shooting till your barrel is good and hot. At this stage you park the rifle firmly on the top of the bench in full exposure to the cool crosswind, and fit the collimator. Very carefully, you note exactly where the cross-hairs line up. As the barrel cools down, you keep a careful watch on that line-up. If there is ANY movement, your groups are doomed in those circumstances. Indeed, if your barrel moves at all when it cools down, especially in still air, best save some dollars for new one. Whilst the collimator is still in the barrel, but after this part of the trial, you clasp your hand round barrel and fore-end whilst peering through the sight, and squeeze. Watch that fat barrel bend! It is almost beyond belief how much. Now, with the rifle sitting firmly on the bench, and you looking through the 'scope, you get someone to tap the barrel, the stock, whatever. That's how you see the barrel vibrating. Next, you pick up the rifle and, keeping your eye to the 'scope, you raise it upwards until it is vertical. The collimator will probably rise a good 4 or 5 MOA, and the same when it points vertically down. What this tells you is that the barrel is bent downwards by about that much (commonly around 4 to 5 MOA) when in the more or less horizontal shooting position. And it vibrates at the slightest touch, and it moves like it has a mind of its own as it heats and cools. Only the finest barrels are seriously heat-neutral, staying quite straight (well, nearly straight) as they heat and cool. But, back to the main point regarding how sighting systems might affect these matters.

"All very interesting" do I hear you say? Well, I think so, for I have ever found it fascinating to watch British match rifle shooters using iron sights, albeit with lenses to help see the target, shooting the pants off the 'scoped rifles, year after year – until really quite recently, and even at that they are fully "in the hunt" even to this day. British match rifles are mostly set up in one of only two ways. The 'scoped rifles look just as you would expect. They are shot prone, with rests for the forward hand. The other rifles aren't like that. Most of them are "BACK-POSITION" rifles. The shooter lies on his side, feet forward, knees bent a bit, sometimes crossed. The fore-end of the stock (which is often extended to help with this next bit) is rested on the knee. The FEET are kept well out the way, to avoid "TTT" (terminal toe trauma). A comforting point worth noting is that you can only shoot a big toe off each foot once. When the shooting position is adopted, the shooter's head and eyes are about level with the butt-plate. So, that's the place to fasten the rear sight, right on top of the heel of the butt. This produces a sight-radius of 45 to 48 inches. Most front sights contain a lens, commonly +0.5 diopter. With no other lens involved, except for the usual (small) size of peep-hole element at the back, this will produce magnification around 2.5X. Some shooters use / need a second lens at the back (often called a 'clearing lens') to help put it all in clear focus, but some don't. In a word, the sights become a Galilean telescope, but instead of having lenses at opposite ends of a long tube, they are fastened to either end of a rifle. Just like that. The photograph shows the general idea. The young lady pictured performs just fine lying flat on her back - and shoots great too! Shooters can do it in many positions, only one of which is lying on their backs. During the Napoleonic Wars, such few riflemen as Britain had were likely to adopt the back-position as the most effective, as many a senior French Officer found to his cost. We learned just a little about sneaky snipers with rifles from your ancestors, the ones who started that revolution a while back. Remember that? I'll bet if Bill Clinton had been in charge then, he wouldn't have let those guys shoot real guns at our poor British soldiers.

Now then, we get to the tricky bit. Assuming that we all accept a few basic principles, we ought to be able to reach useful conclusions. The things we ought to accept as facts should include,

1. No barrel can remain perfectly straight, in absolute terms. Therefore they all bend.
2. Top shooting standards nowadays are VERY high. Therefore very small things matter.
3. Barrels are never straight anyway when in the (more or less) horizontal aim. They droop.
4. Weather conditions (wind and sun) could affect barrel-straightness from moment to moment.
5. To some extent, most barrels will bend as they heat up, and reverse as they cool off.
6. Nowadays, even a very small improvement could make all the difference to the result.

My thought is this. If we are looking for the ultimate in ***precision shooting,*** we MUST start to think smaller and smaller, finer and finer. Else we stagnate, get bored, and start golfing. (YUKK!). We have two quite different sighting systems, with damn-little in common with each other mechanically or optically. One system, which lets us see the aiming mark greatly magnified and very clearly, suffers the penalty of not compensating for barrel movement. The other system does nothing to help us see the target better than with the naked eye, but does compensate for barrel movement, automatically and instantly, with no action required on the part of the shooter. So, here's the BIG QUESTION – **would it be**

(a) possible, and (b) worthwhile, to devise a system of sighting for *precision shooting*, combining the best of both systems, whereby a 'scope is used, but the objective lens is attached to the front of the barrel? I mean, the eye-piece stays in the right place so you get a decent position, sight-picture and eye-relief, but the front-end lens is mounted on the barrel right down near the muzzle. OK?

Now then, if we had such a thing arranged, we have the best of both worlds, but with a whole pile of difficulties to overcome, which is of course what difficulties are for. In its most simplistic, we take our 'scope (best try this with our not-most-expensive 'scope) and remove the front lens. We replace that lens with an optically flat disk of lens-quality glass, or perhaps a flat filter. The 'scope immediately ceases to work – we see NOTHING through it. Having consulted some optical genius, we have a suitable lens made up and mounted, which can fulfill two criteria. First, we need to mount it on the barrel in a tunnel or lens-holder near the muzzle, and second it must be of the correct power so that it focuses an image of the target into the 'scope (through our new optically flat front window) allowing us to see and aim as before. There have to be problems arising from this sort of set-up. The obvious one is that there would be about two feet of fresh (or not so fresh) air between the front lens and the rest of the 'scope. Would this matter? It might matter plenty if heat-mirage rose from the barrel – which it often will. We solve that with an ultra-light-weight tube between the body of the 'scope and the front-sight lens-holder. Such would also help to reduce (eliminate?) problems of stray light fogging out our view of the aiming mark. Next might be problems of parallax correction. Could this be solved by having the front lens mounted on some sort of light rail which allows some adjustment fore and aft? Perhaps. And so on.

Someone out there must have the ability (I don't), the inclination (I have that) and the means (I certainly don't) to take this on board, experiment, and report. So, GET ON WITH IT, AND TELL ME! I want to know before I go down to that terrible place called "HELL", where there's ranges at every turn, animals of every species to hunt, free and easy abounding, every possible sorts of rifles, shotguns and pistols, even full-autos, all absolutely free for the asking – but no ammunition. That will be Hell. Me, Dave Brennan and Jack Rush are sure to end up there. With any luck we might manage to find a few potatoes and some cans of hair-spray. But please, all you optically-expert shooters out there (there must be some, yes?), get to work and put my mind at ease, one way or another. Who knows, it might just be practical, and if it is, we could take a small step forward towards that elusive goal, the one-hole group of five, exactly the size of one bullet. We wish!

I am assured that this idea could work – in principle. I am also informed that there are problems associated with the distance being lengthened between the two ends of the system, causing a proportional increase in the magnification of the original 'scope. Like, if the original object lens of a 16-power 'scope was 8 inches ahead of the eye-piece, were to be replaced by a lens 24 inches up the barrel (thus now about 32" ahead of the eyepiece lenses), the magnification would rise four times from 16X to 64X, and the brightness would suffer by a factor of four. The brightness loss might not matter too much, and the increase in magnification would have to be tried. Maybe it would be great? Maybe not? You tell me. But then, we could always start off with a lower power 'scope, or go the whole hog and replace some lenses in the eye-piece to keep magnification as desired. Next, I am advised that there could be problems associated with **chromatic aberration and reticulation.** That sounds utterly disgusting – people certainly don't indulge in that sort of perverted behaviour here in Scotland, not in public anyway. However, it seems they could be resolved by the cunning use of filters, probably yellow ones, to replace the original front lens of the 'scope. Now why should I be rambling on telling you optical geniuses your business? There's no reason to, so I'll stop it. The answers to the entire problem are to be offered in full detail, both theoretical and practical, to David Brennan, Editor-in-Chief, PS, in good time for publication prior to the start of Season 1996. And if I am in Hell by that time, be sure to bring the drawings, tools and lenses when you join me, as surely you will. All shooters will – it's automatic for us all. We were condemned to that fate from the first moment we laid hands on a gun and fired a shot.

With baited breath I await the reports to flow in. If PS readers cannot solve this one, there's no hope for any of us. So don't be shy. Think about it, work it out, write it down, and send it off post-haste to PS! Oh, and by the way – if anyone out there does work it out, but doesn't tell, I personally will ensure that rotter is sent straight to Heaven, condemned to spend eternity floating around perfumed clouds among soppy chaste angels, with no guns, no ranges, no hunting, no shooting, no fishing – just perpetual Scrabble. At least down below we would have the guns, and lots of time to think up ways to improvise the ammo and brew some beer. Once we got Old Nick interested we would be in business. He would become interested too, for all bad people are interested in shooting, and *vice versa.* That's true, isn't it? So the 'establishment' tries to persuade us over here anyway. Seriously though, is it possible something interesting might arise from this thinking? You tell me.

My apologies to Nancy Tomkins and Walt Berger for using their names in vain without permission. Such is the price they pay for their fame – or infamy!

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EASY, ACCURATE LONG RANGE PREDICTION

by

Art Pejsa

As emphasis on and interest in long range precision shooting increases, it is ever more important for serious shooters to know more about ballistics. At shorter ranges of 100 or 200 yards, shooters know that variations in ballistics make very little difference to the bullet's flight path, its velocity or other key elements down range.

I'm often told by long range precision shooters that other approximate methods and their tables are simply not accurate at longer ranges of 600 to 1000 yards or more; they add that with my new exact method, program and tables they are finally able to make truly accurate predictions.

I recently got a letter from Geoff Townsend, a shooter from England. It includes a table, computed by my program, that precisely duplicates their measured bullet velocities and trajectories at 1000 and 1200 yards! He wrote, "Your program is nothing short of magic; it's the ONLY one that 'makes sense' at those ranges". The 'also ran' programs as he calls them, include most of those by prominent U.S. companies.

I deeply appreciate this flood of unsolicited testimonials from around the world. Unfortunately, many of our U.S. shooters seem not to care. I often get calls or letters asking if my program can use "more than one BC" or if it has a certain output format. When I explain that my formulas and method permit us to actually match the shape of the drag curve of any bullet, for unprecedented near-perfect accuracy, many don't seem impressed or even interested. For background I urge PS readers to reread my articles in PS that detail all of this, especially the April, 1993 article entitled, "The Birth Of New Easy Ballistics".

I get many questions on how to go about achieving such long range prediction accuracy. Because of its importance, I'd like to, again, summarize how to easily obtain and use the data for such long range precision. Bullets from most cartridges used in long range shooting have a muzzle velocity Vm and retardation coefficient F that keep terminal velocity above about 1200 or 1300 fps and out of the erratic velocity-of-sound zone. For those cases, my formulas are very easy. For precise accuracy we need only the bullet's Vm and its F (or a ballistic coefficient BC). To achieve super-precision at extreme ranges for bullets with different drag curves we also need the slope factor n of their F curves.

To determine the initial F, we need a pair of chronographs. Place one as near the rifle as is practical and place the other out at least 50 yards. A longer distance r between them improves accuracy. Measure and record the velocities, V1 at the near chronograph and V2 at the far one.

Now, define: drop in V, Vd= V1-V2 and average V, Va=(V1+V2)/2. The by definition: F=rxVa/Vd (at Va and at midrange, r/2). If, for example, V1=3000 near the muzzle and V2=2800 at 100 yd (or r=300 ft) : Vd=3000-2800=200 fps and Va=(3000+2800)/2=2900 fps and get: F= 300x2900/200= 4350 ft. (at Va=2900 fps and at midrange, 150 ft).

To get the value Fm, at the muzzle, recall that F decreases n ft or about 1/2 ft per foot of range r. Hence, in this case: Fm= 4350 + 150/2= 4425 ft. This key number quantifies drag for this type bullet. For statistical confidence one should measure the F of several samples of a given bullet type.

To relate this F to a BC, for the Mayevski-Ingalls reference Fr= 246x V^{-45}, for V>2600 fps. At V=3000 fps, Fr= 9029.0. Thus, by definition, in this case: BC= 4425/9029= .490.

Our formulas are at their simplest for slope factor n=.5. Luckily, most modern bullets have drag F curves with n between .4 and .6. n= 0.5 thus provides a fine fit for the vast majority of bullets used in precision long range shooting. Having Vm and Fm, for V>1200 fps we can calculate precise flight paths for such bullets using my bullet drop or trajectory formula:

$$\sqrt{D} = \frac{41.68/Vm}{1/R - 1/(Fm-.4R)}\ , \text{(R in yards).}$$

In this case, with Vm= 3000 fps and Fm= 4425, at, R 200 yd:

$$\sqrt{D} = \frac{41.68/3000}{1/200 - 1/(4425-80)}$$

$=2.913$, or $D(200)=(2.913)^2 = 8.48$ in.

With a small calculator, you are invited to verify that: D(400)=37.61, D(600)=94.70, D(800)=190.58, D(1000)=341.96 in. These drop values are accurate to .05 inch out to over 1000 yd, (less than the round-off error to the nearest 0.1 inch!).

Using drop values each 100 yd out to 1000, we now determine an accurate flight path for this load. First, add to each the scope or sight line height S above the center of the bore line. In this case, for S=1.5 in., total drops below the sight line, (D+S), are:

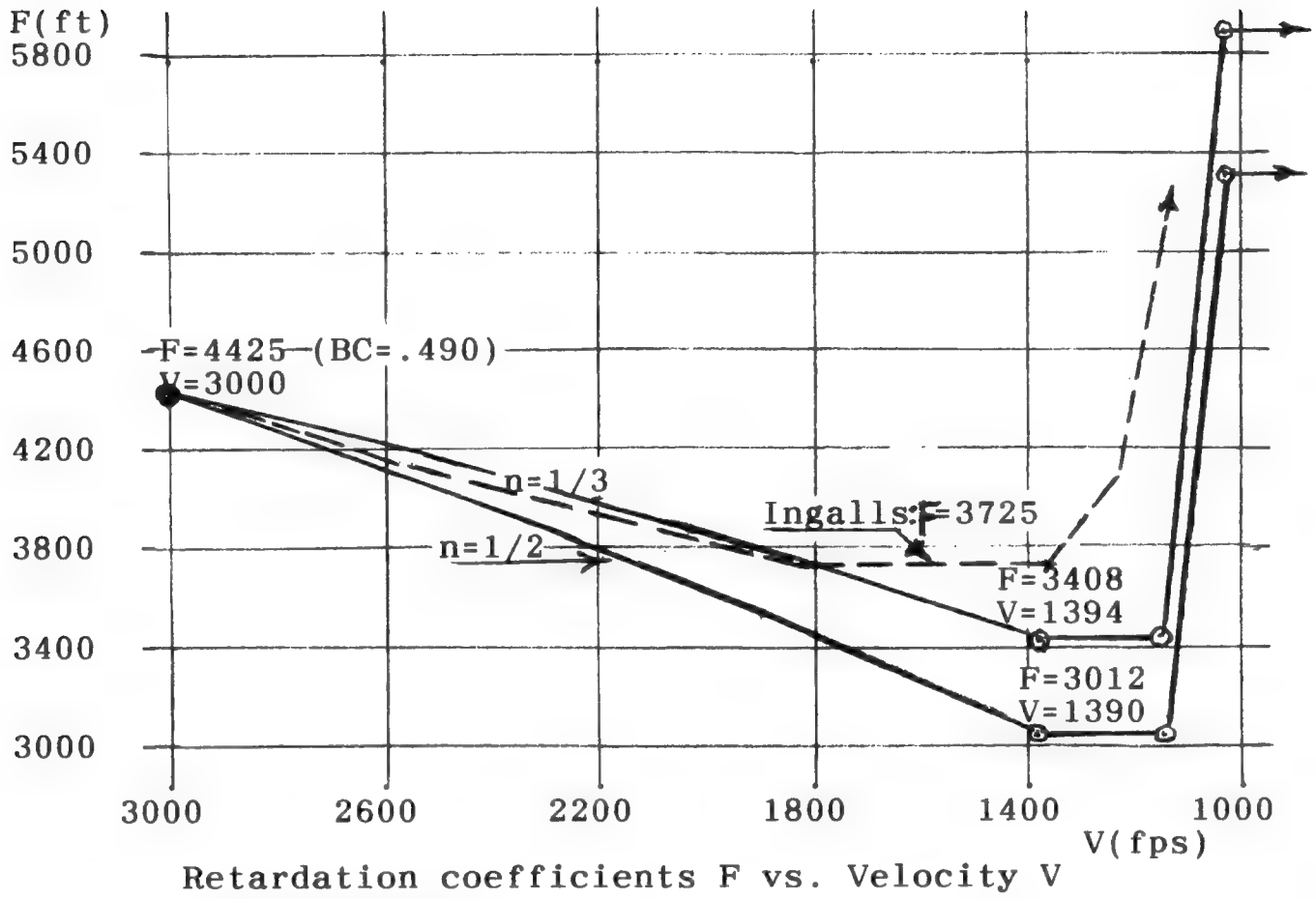
R(yd)	100	200	300	400	500	600	700	800	900	1000
D(in.)	2.0	8.5	20.1	37.6	62.1	94.7	136.9	190.6	257.9	342.0
S(in.)	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5	1.5
(D+S)	3.5	10.0	21.6	39.1	63.6	96.2	138.4	192.1	259.4	343.5

We then rotate the bore line upward a few minutes of arc (moa) so that it intersects the sight line at the desired "zero-range" Z. For the case Z=200 yd, we must adjust or tilt the bore line 10.0 in. at 200 yd or K= 5 in. per 100 yd. This subtracts 5.0 in. per 100 yd from the above negative (-) drop values to produce net drops below the sight line:

R (yds)	100	200	300	400	500	600	700	800	900	1000
-(D+S)	-3.5	-10.0	-21.6	-39.1	-63.6	-96.2	-138.4	-192.1	-259.4	-343-5
+KxR	+5.0	+10.0	+15.0	+20.0	+25.0	+30.0	+35.0	+40.0	+45.0	+50.0
Net (in.)	+1.5	0.0	-6.6	-19.1	-38.6	-66.2	-103.4	-152.1	-214.4	-293.5

We have just calculated a super-accurate flight path like those published by manufacturers for their various loads — but this one is probably far more accurate for this load!

Now, to find the proper sight line adjustment for a hit at each range, we translate these net drops into minutes of arc (moa). Each moa moves impact precisely $\pi/3$ or 1.0472 inches per 100 yards of range. Hence, divide the net drop at each range R, by 1.0472 x R/100. From above, for instance, the adjustment for 300 yd is, 6.6/(3.1416) = 2.10 moa. For a scope that has 1/4 moa clicks, 2.10 moa would of course imply: 2.10 x 4= 8.4 clicks for a hit at 300 yd, etc.



Retardation coefficients F vs. Velocity V

Extreme Accuracy at Extreme Ranges

As mentioned above, for utmost accuracy at extra long ranges, we must determine the steepness or slope exponent n of the F curve. To do this we need another measure of F. Ideally we'd like to also set up chronographs near maximum range but at extreme ranges a shot could hit and destroy a chronograph. Let's assume, however, that we measure V1= 1575 fps at 900 yd and V2= 1425 at 1000 yd, and find: F= 300x 1500/150= 3000 ft (at V= 1500 fps and at 950 yd or 2850 ft). Now, since F decreases n per ft of range: n= (4425- 3000)/2850 = .50

The alternative to setting up chronographs at extreme ranges is to use reduced loads that produce Vms that are somewhat higher than the V at maximum range. In this 1000 yd case, use loads with Vm at about 700 or 800 yards. Using my down range velocity formula for n=1/2: V= Vmx(1-3R/2Fm)^2; in this case, at 700 yd: V(700)= 3000x(1-3x700/(2x4425))^2 = 1745 fps.

With reduced loads, let us assume that we measure: V1= 1585 near the muzzle and 30 ft downrange we measure V2= 1455 fps. Thus: F= 300x 1520/130= 3508 ft, (at Va= 1520 fps). Since we know only Fs at two V's (but not at range R), we use the form: F= bx V^n and must use logarithms to find n. We have found: 4425 =bx (3000)^n and 3508= bx (1520)^n. Dividing, 4425/3508= (3000/1520)^n. Solving for n: ln(4425/3508)= nx ln(3000/1520). Hence, n= .232/.680=.341. Note: Log ( ) or Ln( ) are found on "student" type calculators)

This value of n, near 1/3, is typical of blunter nose shapes like semi-Spitzers. It implies a less steep supersonic F curve. Note that F thus decreases about 1/3 ft per ft of range (instead of 1/2). Hence, for extreme accuracy our value of F, near the muzzle, should be changed to:

Fm= 4350+ (1/3)x 150=4400 ft. (instead of 4425).

The above calculation for n is thus altered slightly so that ln(4400/3508)= nx ln(3000/1520), and n=.227/.680= .333

This means that our F curve closely follows: F= bx V $^{1/3}$= bx $\sqrt[3]{V}$ Solving for b: 4400= bx $\sqrt[3]{3000}$, or b= (4400/14/42) =305.08. Hence, for this bullet, at supersonic V's: F=305.08x $\sqrt[3]{V}$.

If velocity at maximum range falls below 1300 fps, we should also know more about the drag F curve, in particular its minimum. As can be seen from the figure, F reaches a minimum at Vs between about 1150 and 1400 fps. To find F(min), use a reduced load with a Vm around 1400 fps so that the average of two chronograph readings, Va is about 1200 to 1300 fps.

With further reduced loads, assume that we measure: V1= 1352 and 300 ft down range, V2= 1238 fps. In this case we find: F(min)= 300x 1295/114= 3408 ft, (at 1295 fps). This gives us a key point on our F curve. Now, extending our F curve found above down to this assumed minimum value, 3408 ft, we find the "break" velocity Vk at which our F curve levels off. Using our F curve: 3408= 305.08x $\sqrt[3]{Vk}$, and Vk= (3408/305.08)^3 = 1394 fps, as show in the figure.

F stays roughly constant (and the F curve generally level) down to about 1150 fps. Below that, as shown in the figure, the curve rises very steeply until F is almost doubled at around 1000 to 1025 fps. At lower V's, F again remains roughly constant. To determine that value of F, one must of course measure F at such subsonic V's in the same manner as has been demonstrated here for supersonic V's.

This change in n, and the rate at which F decreases, changes the formulas for calculating down range ballistics data. In particular, for n=1/3, the correct mean value of F to be used in calculating drop D is: $\bar{F}$= Fm-3nR/4; becomes: Fm-.25x R. That is, the mean $\bar{F}$ decreases 25 ft per 100 yd (instead of the 40 ft per 100 yd used above for n= 1/2).

Continued on next page

EASY, ACCURATE LONG RANGE PREDICTION

Continued

We now calculate the effects on flight paths of changing n from 1/2 to 1/3. For R=200 yd,

$$\sqrt{D}= \frac{41.68/3000}{1/200-1/(4425-50)} = 2.91, \text{ and } D= 2.91^2 = 8.4784 \text{ in.}$$

This is .0056 in. less than the D(200) calculated earlier, using $\bar{F}$= 4425 - 80= 4345 ft. Both values round-off to 8.48 in. In the table below, D's are the values using $\bar{F}$=4425-.25xR; D's are those found earlier using $\bar{F}$=4425-.40xR. The bottom row shows their differences.

R(yd)	200	400	600	800	1000
D(in.)	8.48	37.50	94.03	187.99	333.76
D'(in.)	8.48	37.61	94.70	190.58	341.74
Diff.(in.)	0	.11	.67	2.59	7.98

Note how radically the difference grows; from 0.11 inch at 400 yd there is a 75-fold increase to 8.0 in. at 1000 yd!

Effect on Down Range Velocity and Energy

The effect, on down range velocity, of using a drag curve with the wrong shape is also dramatic. To illustrate, we shall caclulate velocity at 1000 yd with n=1/2 and n=1/3.

For general n, down range velocity $V= Vmx (1- 3Rn/Fm)^{1/n}$

As was used earlier: for n=1/2, $V= Vmx (1- 3R/23Fm)^2$

For n=1/3, $V= Vmx (1-R/Fm)^3$.

For Fm=4425 and Vm= 3000 at R= 1000 yd:

for n=1/2, $V= 3000x (1-1500/4425)^2 = 1311$ fps.

for n=1/3: $V= 3000x (1-1000/4425)^3 = 1391$ fps.

We thus find a large difference of 80 fps due only to the difference in slope factor n.

Energy at 1000 yd would also be changed considerably:

for a 150 grain bullet, kinetic energy $E= \frac{150x V^2}{450,380}$

For n=1/2, $E= \frac{150x (1311)^2}{450,380} = 572.4$ ft. lb.

For n=1/3, $E= \frac{150x (1391)^2}{450,380} = 644.4$, an increase of 72 ft. lb.

Changes in Flight Time and Cross-wind Deflection

A correct formula for flight time is:

$$T= \frac{Fm}{(1-n)xVm} \times \left[\left(\frac{Vm}{V}\right)^{(1-n)} - 1\right]$$

For n=1/2, it becomes simply: $T= \frac{1/Vm}{1/3R- 1/2Fm}$

At R=1000 yd: $T= \frac{1/300}{1/3000- 1/8850} = 1.513$ sec.

For n=1/3, $T= \frac{4425}{(2/3)x(3000)} \times \left[\left(\frac{3000}{1391}\right)^{2/3} -1\right] = 1.481$ sec.

We thus find a time difference of .032 sec. at 1000 yards.

Cross-wind deflection depends on the difference between actual flight time and that of an ideal bullet with no drag. That is:
W= 176x(T- 3R/Vm), (inches per 10 mph cross-wind)
In this case, 3R/Vm= 3000/3000 = 1 sec. From above;
for n=1/2: W= 176x (1.513- 1.00)= 90.3 in./10 mph;
for n=1/3: W= 176x (1.481- 1.00)= 84.6 in./10 mph
Hence, we find a difference of 5.7 inches of deflection due to a 10 mph cross-wind, due only to the change in n.

Summarizing the above

For high accuracy at long range, the shape of the drag curve must be accounted for, its steepness or slope factor n in particular. For n=1/2 vs. n=1/3, difference in bullet drop D at 1000 yd is 8.0 in.; this is 75 times greater than the 0.107 in. difference at 400 yd! This, in spite of using the same initial Fm (or BC).

The shallow Mayeski-Ingalls drag curve has n=.30 for V from 2600 to 1800 fps, and n=0 (meaning that the curve is flat) for V from 1800 to 1370 fps, and it slopes upward below 1370 fps. This means that the Ingalls reference is even shallower than the F curve of our example with n=1/3. Ballisticians defend their use of the Ingalls curve by noting how small the errors are. This is so mainly because tables are rarely given for ranges beyond 500 yards; furthermore, until lately, few knew what the correct flight path values ought to be. Nowadays, with more marksmen shooting with ever greater precision at 1000 yards or more, such errors are important.

Due to a change in n from 1/2 to 1/3, there is also a difference in velocity of 80 fps at 1000 yd. The corresponding change in bullet energy at 1000 yd is 72 ft.lb or 12%.

The change in flight time T is .032 sec. This accounts for a difference of 5.7 inches deflection due to a 10 mph crosswind. This can be significant in precision target shooting.

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The Development of the Navy .300 Winchester Magnum Cartridge Configuration

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Throughout the 1980's the Navy focused on improving weapons and ammunition for match competition and sniper use. The Navy funded several efforts that investigated cartridges for long range anti-personnel applications that would provide enhanced performance over existing 7.62x51mm systems. Among those cartridges investigated were the .338/.416 and the .30/.338 wild-cat cartridges. None of the systems based upon wild-cat cartridges were found to be adequate for use in a military environment. In the late 1980's the focus was turned to the .300 Winchester Magnum (.300 WinMag) cartridge. This was because the .300 WinMag cartridge was (1) commercially produced in economic quantities; (2) commercial weapons could be easily modified for use in a military environment; and (3) the cartridge was proven in long range match competition.

The two users of this cartridge in the Navy were to be the Match Competition Team and Naval Special Warfare Forces. Because the annual requirement for the Match Team would not represent an economic quantity and was small in comparison to the annual requirement for Special Warfare Forces it was decided that one cartridge configuration would be used for both applications. This also reduced the development and logistical support costs. The general requirements for the cartridge were (1) the projectile had to be consistent with the Law of War obligations of the United States; (2) the chamber pressure had to be within SAAMI limits at 70°F, 125°F and -40°F; (3) velocity was to be maximized while staying within the SAAMI pressure limits; and (4) a 10 inch extreme spread at 1,000 yards was desired, a 15 inch extreme spread was required. To achieve maximum case capacity and reduce bullet jump it was decided that the cartridge overall length would be 3.50 inches, maximum, which is in excess of the SAAMI overall length requirement. This overall length can be accommodated by .300 WinMag weapons which have a match chamber such as that in the Navy .300 WinMag rifles. The intended weapons that the .300 WinMag cartridge would be used in were the McMillan M83, McMillan M86 and Remington 700 bolt action rifles.

Commercial procurement rather than configuration development was the initial path utilized by the Navy in an attempt to meet the aforementioned requirements. In 1987, contract N00164-87-C-0324 was awarded to Federal Cartridge Company of Anoka, MN for the production of .300 WinMag cartridges. The average extreme spread was not to have exceeded 8.0 inches at 600 yards or 3.5 inches at 300 yards. The muzzle velocity of the cartridges at 70°F was to be 2950±30 fps, with a maximum standard deviation of 25 fps. The projectile had to be between 180 and 190 grains and be of a Full Metal Jacket (FMJ) design.

Federal Cartridge made a proposal which Navy accepted, to use a 180 grain Sierra MatchKing™ Hollow Point Boat Tail (HPBT) projectile with the nose spun shut to meet the requirements of contract N00164-87-C-0324. Due to range constraints, the accuracy requirement was changed to 2.3 inch maximum average extreme spread at 200 yards. Table 1 contains the results from the First Article Sample (FAS) tests and the Lot Acceptance Test (LAT) performed on these cartridges. All cartridges were produced in one lot, FC-88F001-001 using Rp15 propellant.

Distribution Statement A: Approved for public release; distribution is unlimited (6/94).

Acceptance Test: Requirement	First Article Lot FC-88A001A001	Production Lot FC-88F001-001
Velocity: 2950±30 fps	2923 fps	2941 fps
Chamber Pressure: w/i SAAMI	Acceptable	Acceptable
Accuracy: 2.3" max average ES	2.3" average	1.615" average
Function: 60 rounds/temperature	Acceptable	Acceptable

Contract N00164-87-C-0324 Test Results
TABLE 1

After these cartridges were fielded in 1988, it was discovered by the Navy Match Rifle Team that the projectile was becoming unstable at ranges beyond 800 yards and was passing through the target sideways at 1000 yards. Also, Naval Special Warfare personnel reported similar occurrences with this ammunition during limited evaluations. Further testing conducted by Crane Division, Naval Surface Warfare Center (NAVSURFWARCENDIV Crane) verified these reports. It is conjectured that the instability was caused by the burnished tip. The bullet was designed to have stable flight characteristics as an open-tip projectile. The burnishing of the tip closed the open-tip and shortened the projectile. This caused an offset in the center of gravity which would result in instable flight at or about the speed of sound (the approximate velocity of the projectile at 800 yards).[1] It is also conjectured that the bullet lost some of its symmetry when the tip was burnished; this would further degrade the gyroscopic stability of the projectile. The projectile was ruled by the Navy Judge Advocate General (JAG) to be unacceptable for use in combat based upon the appearance of an open-tip despite the burnishing.

In order to field a cartridge acceptable for use in combat, a quantity of cartridges from lot FC-88F001-001 were modified. The 180 grain projectile was removed and a 185 grain Lapua FMJ projectile was pushed in its place as an interim solution. The average velocity of the modified cartridges was 2,930 fps at 70°F. The modified cartridges produced an average extreme spread of 9.1 inches at 800 yards and 15.4 inches at 1000 yards. Accuracy testing also revealed that the 185 grain projectiles were impacting approximately 14 inches higher than the 180 grain projectile at 1000 yards.

In 1990, a contracting action was initiated to procure .300 WinMag cartridges containing the 185 grain Lapua FMJ projectile and using IMR4350 propellant. This action resulted in contract N00164-91-C-0040. The cartridges were manufactured by Hunting Shack Manufacturing of Missoula, MT. Table 2 details the performance characteristics of the cartridges produced on contract N00164-91-C-0040.

[1] The average extreme spread at 800 yards of the cartridges from lot FC-88F001-001 was 12.3 inches.

Acceptance Test	HSM91E010-001	HSM91E010-002	HSM91G010-003
Velocity @ 70°F	2,987 fps	3,008 fps	3,009 fps
Chamber Pressure	Exceed SAAMI @ 125°F	Exceed SAAMI @ 125°F	Exceed SAAMI @ 125°F
Accuracy @ 200 yards	1.66 average ES	1.47 average ES	1.37 average ES
Function	Acceptable	Acceptable	Acceptable

Contract N00164-91-C-0040 Test Results
TABLE 2

User evaluations of these cartridges revealed that the long range accuracy performance was not adequate. The fact that the chamber pressures were in excess of SAAMI limits was also a concern. To correct these problems an effort was funded by the Navy to develop a cartridge configuration that would eliminate chamber pressure problems and improve long range accuracy performance. In 1990 the M852 cartridge which contains a 168 grain Sierra MatchKing™ HPBT projectile was authorized for use in combat by snipers by the Army and Navy JAG offices. The paramount reason being that the intention of the open tip design of the MatchKing™ projectile is not to increase the wounding capability, but to improve the flight characteristics. Due to the JAG decision and accuracy concerns, it was decided that a 190 grain MatchKing™ type HPBT projectile would be pursued instead of the 185 grain FMJ projectile.

The following commercial propellants were evaluated for potential use in the .300 WinMag cartridge: Reloader (Re) 19, Re 22, Accurate Arms (AA) 3100, IMR4350 and IMR7828. Various loads were subjected to chamber pressure and muzzle velocity tests before proceeding with any other testing. A load that was within SAAMI chamber pressure limits and produced sufficient velocities could not be found with the IMR4350 propellant so it was dropped from the test sequence after the chamber pressure and muzzle velocity sequence. Chamber pressures in excess of SAAMI were encountered at 125°F with the AA3100 propellant, however the accuracy of this propellant was assessed since accuracy testing was to be conducted at 70°F. Cartridges containing Re 19, Re 22 and IMR 7828 were found to have the best chamber pressure characteristics with respect to the SAAMI recommended limits. The velocity of cartridges containing Re 19 and Re 22 were found to be least affected by changes in temperature. The chamber pressure of cartridges containing Re 22 was found to be least affected by changes in temperature.

Table 3 details the accuracy performance that was obtained with the various propellants at 200, 600 and 1000 yards. Numbers in parenthesis following propellant names indicate different loadings. Cartridges containing Re 19 or Re 22 were consistently the best performers at all ranges. A statistical comparison showed that the accuracy performance of the Re 19 and Re 22 propellants was statistically better than that of the other propellants tested.

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Propellant Load	200 Yard Average ES	600 Yard Average ES	1000 Yard Average ES
Re 19 (1)	1.62"	5.75"	10.79"
Re 19 (2)	1.63"	7.20"	13.37"
Re 22 (1)	1.79"	5.56"	10.68"
Re 22 (2)	2.40"	6.24"	14.02"
AA3100	2.08"	7.65"	13.32"
IMR7828 (1)	1.86"	7.46"	12.18"
IMR7828 (2)	2.61"	7.71"	13.48"

Accuracy Performance of Development Loads
TABLE 3

A performance specification, HS/2024/C91/621, was prepared to support procurement. The specification details quality assurance requirements and performance requirements of the cartridge. The specification requires: (1) the use of a 190 grain HPBT match projectile; (2) the use of Re 19 or Re 22 propellant; (3) commercial 70/30 alloy brass case; (4) a commercial match quality primer; (4) a nominal velocity of 3000 fps; (5) pressure limits within SAAMI at -40°F, 70°F and 125°F; and (6) an average extreme spread of no greater than 2.25 inches at 200 yards, the maximum allowable individual extreme spread is 3.5 inches.

In 1992, Crane Division, Naval Surface Warfare Center (Code 2024) constructed a lot of 20,000 each .300 WinMag cartridges to prove in the configuration of the aforementioned specification and to support match competition requirements. Table 4 details the performance characteristics of the cartridges assembled by NAVSURFWARCENDIV Crane.

Acceptance Test	NSW92D010-001
Velocity	2937 fps
Chamber Pressure	Within SAAMI at all temperature conditions
Accuracy	2.0" average ES at 200 yards
Function	Functioned safely and reliably at all temperature conditions

Lot NSW92D010-001 Performance Characteristics
TABLE 4

In 1992, a procurement action was initiated utilizing the performance specification HS/2024/C91/621. This resulted in contract N00164-92-C-0137 being awarded to Federal Cartridge Company. The performance of the FAS and subsequent production lots are detailed in Table 5.

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Acceptance Test: Requirement	First Article Lot FC93A010A001	Production Lots		
		FC-93B010-001	FC-93F010-002	FC-93G010-003
Velocity: 3000±50 fps	3001 fps	2997 fps	3001 fps	2975 fps
Chamber Pressure: w/i SAAMI	Acceptable	Acceptable	Acceptable	Acceptable
Accuracy: 2.25" max average ES	1..30" average	1.47" average	1.97" average	1.72" average
Function: 180 ctgs/temperature	Acceptable	Acceptable	Acceptable	Acceptable

Contract N00164-92-C-0137 Test Results
TABLE 5

Cartridges have been subjected to type classification tests in accordance with Navy requirements. These tests included the following sequential tests: 28 day Temperature and Humidity, Transportation Vibration, 4 day Temperature and Humidity, and 40-foot Drop. Other type classification tests that the cartridge has been subjected to include: 5-foot Drop, Rough Handling, Toxic Fumes, Sound Pressure Levels, High Temperature, Low Temperature, Temperature Shock and Humidity. The cartridges performed safely and reliably after being subjected to the type classification tests.

The cartridge configuration defined by HS/2024/C91/621 was authorized for use in combat by snipers on 23 Nov 1993 by the US Army JAG with US Navy JAG concurrence.

Cartridges have been released to the Navy Match Rifle Team and select Special Warfare Units for limited evaluations. The Match Rifle Team has indicated that the competitive level of the shooters has increased because of these cartridges. Initial results from Special Warfare are highly favorable.

The .300 WinMag is the caliber of choice to fill the operational capability divergence between the 7.62x51mm and the .50 Caliber. The 7.62x51mm is effective to ranges around 800 yards and the .50 caliber could be employed at ranges between 800 and 1200 yards. However, due to the accuracy and muzzle signature characteristics of the .50 caliber it is not desirable to employ this system these ranges for anti-personnel purposes. The .300 WinMag provides pin-point accuracy at these ranges (and lesser ranges) with a muzzle signature slightly larger than the 7.62x51mm.

The cataloging information for the .300 WinMag cartridge configuration defined by HS/2024/C91/621 is DODIC A191, NSN 1305-01-018-1547. The cartridges are packaged 240 per M2A1 ammunition can, 2 each M2A1 ammunition cans per wirebound box and 36 each wirebound boxes per pallet.

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Practical Long Range Varmint Shooting

by
Jack Rush

This spring has provided good weather for long range shooting. I have set up a temporary, moveable and removable range. This has been facilitated by the construction of a sturdy portable folding leg bench. Lynn Laubach, one of our PS subscribers, built the frame for the bench from one inch square tubing, with box joint legs. It is a good compromise between weight and maximum stability.

The range extends for an unlimited distance down a dirt road. So far, 1000 yards is the farthest I have shot. I try to simulate field varmint shooting conditions. That is, I don't confine shots to a single range. I shoot at all ranges from four hundred to a thousand yards. I am not sure of the distance until I finish shooting. I use none of the amenities common to formal target range shooting, attempting to solve the problems one faces in varmint hunting.

I have learned a couple of interesting things. First, a varmint bullet that shoots in the three's and four's at a hundred yards will most likely be a winner out to 400 yards. Beyond that, good performance on paper at one hundred yards is no guarantee of decent performance at extended ranges. The reason for that is simple. No matter how calm the day may seem, air is always moving. Bullets of lesser ballistic coefficient are most affected by air movement (wind). Velocity loss (not bullet weight) is the most significant factor in wind drift. Time of flight is not the most significant factor, though time of flight is related to velocity loss and obviously thus to ballistic coefficient.

One could then say that for long range shooting, very long, slender and heavy bullets fired from a tight twist rifle would be best. This is true, beyond a point. You give away a great deal of trajectory at shorter ranges with heavy bullets. The bullet drop guessing game becomes a significant factor much earlier than it does with high velocity bullets. As a general rule of thumb, a ten percent increase in bullet weight would give away the capability of more than ten percent of the velocity. Decreased velocity will require a heavier bullet to travel at least 700 yards, usually, to overcome and equal the trajectory of a lighter, faster bullet. Thus no trajectory gain from increased ballistic efficiency until you get way out there. Remember, we are talking field shooting where ranges vary a lot. You can't put all your eggs in the thousand yard basket unless you are confining your shots to those extreme ranges. At ranges less than seven or eight hundred yards, what you gain in wind drift with heavy bullets, you lose in trajectory. The long, heavy bullets are winners in both categories beyond those ranges.

If you use a cartridge large enough to drive the big bullets fast enough to shoot flat at closer ranges, you pay at the butt end and in the barrel throat. There ain't no free lunch.

Although I have not yet had the opportunity to play with a good ballistics program, I find that ballistic tables that are available to me give almost no usable clues regarding point of impact at ranges much beyond a quarter mile. I will soon have a Gamma model Chrony with program and am anxious to see how much guessing it will take out of the game.

On days when the range surface is damp, (no dust), I find myself completely in the dark. I fired seventy five shots at about 700 yards with a 22/250 without touching a single gallon jug, or even an 18 by 24 inch target. This with a rifle and load that wins local bench matches. The frustration drove me to drink.

Using my 250 Savage, and 250 Improved I had little difficulty making regular hits at that range. The reason was twofold. I know or can make a very educated guess where these guns shoot at most ranges to a thousand yards, and the bullets I use in these rifles have good ballistic coefficients. Wind drift stays between much narrower parameters.

Most of the time when shooting prairie dogs the only meaningful clue you get is dust. Without it you are lost. Simply cranking the crosshair down to the dust spot while the rifle is secure in the bags puts you on target. However, with bullets of poor ballistic coefficient, the slightest breeze will confound your efforts. Head and tail winds are as big a problem as side winds.

In varmint shooting you seldom if ever have wind flags to guide you. While most see mirage as the enemy, it can be quite useful. Watch the mirage movement beyond your target, and try to fire shots during similar movement. The direction of the mirage movement gives you the first clue as to where to hold off. Usually the mirage represents sort of an average over the range. A stationary shimmer tells you that you are dealing with either a head or tail wind, easily determined by tossing up a handful of grass. I blow cigarette smoke, but that is because I am one of the politically incorrect guys.

I have been doing long range shooting for many years. This spring I have attempted to do it in a systematic manner. I am a long way from finishing my conclusions as to the best equipment and methods for varmint field shooting.

Long range shooting has always been one of my passions. Perhaps it began when I tried for pigeons at 75 or more yards with my Apache 25 caliber round ball pellet rifle as a young farm boy. The rifle had a smooth bore .17 cal insert that allowed it to shoot common BB's but came into its own with the pure lead quarter inch balls in the rifled bore. That it had plenty of power for a little kid became apparent one day when a preacher visited the farm.

The preacher was leaning against the hog lot fence, attempting to engage my father, who was slopping hogs, in casual conversation.

My dad had little use for preachers. The hogs had about as much interest in church as Dad had.

Unable to arouse much response, the preacher decided to try another tack.. He turned to me and expressed an interest in my pellet gun, with which I had just dispatched an English sparrow from the hog house roof.

There is a real trick to pumping up a pellet rifle, quickly learned but not something that comes naturally. I handed him the gun and he began to sweat on about the third stroke, which no doubt surprised him as he had watched me easily pump in several strokes earlier. Undaunted, and with a bit of manly pride, he managed to surpass the six stroke limit. I stopped him at ten, suggesting that was plenty. He dropped in a BB (I usually shot it with the .17 insert in place, as the 25 cal pellets were too darn expensive), and let fly at a wooden hog

DRAWING BY TRAVIS RICHARDS, POPLAR, MONTANA
SUBMITTED WITH HIS PERMISSION.

feeder inside the fence where dad was. I think the preacher expected the BB to bounce harmlessly off, or at best stick in the surface of the wood. The projectile ripped easily through both sides of the wood structure and hit a young hog in the rear, sending it squealing through the mass of pork, exciting the others to one of those instant, woofing, mass stampedes that last only seconds but are so common to startled young pigs.

One of the pigs bumped Dad in the back of the knees collapsing his legs and sitting him down in the hog mess, simultaneously dumping a bucket of sour slop in his lap. The air was rather blue for several minutes. I don't recall exactly what happened next, except that I was holding the rifle and the preacher went to the house to distract my grandmother's efforts to cook supper. He kept an eye out for Dad and disappeared out one door when Dad came in the other. I am sure my grandmother asked him to stay for supper, as that was the custom of the time. His failure to stay disappointed me no small amount, as we didn't get much entertainment on the farm, and I'm sure Dad would have provided some.

I have been a greater devotee of rifles ever since. Religious instruction made a lasting impression on a farm boy in those days.

My long range shooting efforts with the pellet gun were usually of limited success. A round ball has the ballistic coefficient of a coconut cream pie.

I had access to a Winchester .22 pump rifle, but could only afford 22 shorts, which were about thirty five cents a box, and much cheaper than those beautiful, slender long rifles.

My uncle Earl lived down a lane about a quarter mile away. He had become single by that time and lived in high style. He just smoked stinky cigars, drove around in a '32 Ford pickup and drank anything but water. Earl was a very advanced farmer, being an early ecologist, though he didn't know what an ecologist was and you would have had to catch him pretty early in the day for him to be able to pronounce it.

His farm was a vast wetland, mostly covered by tall aquatic grass. Sometimes he planted corn in the high spots, presumably to feed the wildlife that abounded there.

He had a hired man with the unlikely name of Omar Casselberry. Omar's job was to drive a rickety old John Deere tractor around the perimeter of the swamp and harvest the crop with a 20 gauge single shot. The tractor was the only vehicle Omar ever drove, as even then you weren't likely to keep a driver's license if you never drank water. He also trapped muskrats in their prime, presumably to help pay for water substitutes.

Earl and Omar recognized only two game seasons. Prime fur time and all the rest of the year. Game wardens were a rare and endangered species in those days.

Continued on next page

PRACTICAL LONG RANGE VARMINT SHOOTING

Continued

Besides living in a style befitting royalty, Uncle Earl possessed the most impressive long range rifle I had seen up to that time. It was a model 5 Savage clip fed .22 with a supply of high speed hollow point Super X's. I rode my bike to his place, hid whatever armament I might have left home with, and went inside. Neither Uncle Earl nor Omar had any great interest in sharing conversation with a nine year old who drank water, so they were glad to send me off with the Savage and a handful of precious Super X's.

With that bolt action rifle in hand, I was king of the swamp. Many a cottontail bit the snow, and the family got tired of fried rabbit. I began to be more selective. and only took shots that I presumed were beyond the skills of any other living human. Thus was a long range shooter, not a hunter, born. I can't tell you how my dwindling success rate delighted the family. We wasted nothing, but, boy, Grandma sure was tempted. Rabbit for supper became about as popular as preachers.

I tended to specialize as a varmint shooter for a long time. About 60 years. Over time I began to be more and more interested in the long range potential of centerfire rifles of tolerable recoil. Note tolerable. I won't say I was a skinny kid, but I was of little use as a windbreak. I considered 12 ga shotguns to be a mode of transportation, even if it was always backward.

Lacking a massive frame, I stuck with cartridges in the 22 to 25 caliber range. I shot my cousin's Army 30-06 right after the big war. He said it was powerful enough to kill an elephant, and I know it would have if it had been standing where I was when I pulled the trigger. This encouraged me to stay with the smaller bores.

Then, as now, I tended to be rather absent minded. I became immersed in experimental projects, with little thought of side effects. Using my Daisy Red Ryder, I took a poke at the left headlight of our '36 Chevy from a great distance. Amazed at the result I walked to an even greater distance and tried again on the OTHER headlight. Both shots required ridiculous Kentucky elevation. Both connected. Dad proved to be little interested in ballistic science. My mother, who had sworn at my birth that this child would never have a gun, even a toy one, continued to give her support. They must have recognized my potential genius, however, as my pursuit of ballistic knowledge was but briefly interrupted.

By the time I was fourteen, I came under the tutelage of Chuck Hibbs, a great shooter and sportsman. He loaded his own for a Remington 722 .257 Roberts. I soon acquired a 250 Savage, which I handloaded with lead bullets for small game and 60 grain hollow points for ground squirrels and woodchucks. We spent a lot of happy hours in the green hills, and eliminated many pasture diggers.

One clear, still morning we sat atop a hill viewing the flood waters of spring on the Iowa River. The nearest water was probably a half mile away, and from our high vantage point it was a broad expanse, nearly mirror flat, punctuated by snags and stumps. Chuck wondered if he shot at a stump about a mile away, whether I could see his bullet hit through binoculars. Sure enough, the bullet strike was a bright flash. It was apparent that a hit on a stump would be visible by the absence of a brilliant splash. I don't remember how many hits, if any, we made at a mile that morning, but I do remember using all the ammunition we had. If I learned anything, it was how much difference in drop a little extra range made way out there, and how far bullets drifted even in what seemed to be no wind conditions. This was REAL long range shooting and I loved it.

In recent years I have done quite a bit of informal testing on long range drop. I was especially interested in .22 long rifle ammunition, because it drops so radically.

I had a three hundred yard range setup, and was experimenting with scope settings and drop of 22's. A thirty inch round saw blade was hung on a fence at three hundred yards, and I had gradually cranked the scope up so that a little Winchester 63 autoloader was set to ring it. Otherwise one had to hold way up into the sky to hit it. My devious mind conceived a plan. Every Sunday morning a benchrester or two would drop in for services, sometimes a regular crowd would gather. They usually brought a variety of weapons, as there were no purists in the crowd. Eventually we would get around to shooting for quarters in pistol and 22 rifle matches. One morning I bet one of the more ego involved shooters that he couldn't hit the saw blade with his 22. After a few attempts he gave up, his nose in the air, saying that it was just too far for a 22. At this point I gave a nod to my ten year old daughter, Jennifer, and she stepped forward with the little Winchester. She rattled ten shots through it as fast as the action would cycle. The first of the ten began to ping against the blade and the sound of it got back to us about the time she fired the last round. It sounded like a hail storm out there. The guy packed his stuff and I didn't see him for a month.

One thing was obvious in these experiments. At the extreme range of a 22 rimfire, it is useful only at the range where it is sighted in to hit. That, on a larger scale, is true of any rifle. That's why they put big elevation knobs on varmint scopes. The point blank range is just extended, the higher the velocity and better ballistic coefficient of the bullet. The problems are the same, you postpone them with faster, better bullets.

If you primarily shoot at ranges less than 400 yards with a good, flat shooting varmint rifle you are better off with the most accurate bullet you can buy. At ranges beyond 400, you should look at bullets that MIGHT perform less well on paper at short ranges but which are of better ballistic coefficient and buck the wind better, even if they shoot marginally poorer at the 100 yard mark.

If you shoot at only ranges beyond seven or eight hundred yards, you should consider tight twists and very low drag bullets. You can't have it all in one rifle.

I have shot prairie dogs exclusively with patched round balls on some hunts. We used both flintlock and caplock muzzleloaders. They were handmade rifles using the finest barrels ever cut. These were serious rifles, not the stuff of modern imports. They had the accuracy potential of almost any modern smokeless firearm. Yet the longest shot I ever made was 165 yards. Again, the limit was not accuracy, per se, it was wind drift and drop. Ballistic coefficient. Had we been shooting modern quick twist muzzleloaders and the now popular long hunting bullets we would have given away much accuracy at short ranges (unless using specialized bench rifles) but extended our long range capabilities. All things are relative.

My current experiments are without windflags, known ranges or ballistic programs. They are purely to understand the problems of field varmint shooting. Despite years of actual field shooting, I am adding much to my knowledge of what it takes. Remember that we are not talking about absolute known range target shooting.

In summary my conclusions are that:

One rifle will not do it all, one bullet is not always the best choice for all ranges.

Any really accurate bullet, fired out of any good centerfire rifle is fine to a quarter mile.

Drag and velocity (Wind drift and drop) become significant from 400 to 800 yards.

Wind drift is by far the most significant factor beyond 7 or 8 hundred yards.

Very low drag bullets perform best in both drift and drop beyond 7 or 8 hundred yards. They are a disadvantage at lesser ranges.

Spud guns are at their best at ten feet.

Now if you long range varmint hunters wish to put your oar in the water, I would be glad for your input. I am a student, not one who has the final answer. What you may have learned from long range target shooting is valuable, but not necessarily applicable in multi range, no wind flag conditions. Also we are talking about targets that give no lasting indication of where the bullet strikes. There are only two scores, zero and 1.

Besides the rifles, cartridges and bullets, scope capabilities interest me, also. One problem is that scopes often run out of elevation before you have surpassed the range capability of the rifle.

One cure for this is to shim up the rear scope ring to elevate the scope. Usually on a five inch ring spacing, a shim of about .005 will elevate your crosshair 3 feet at a thousand yards. In the curved trajectory, distance involved, and mostly, minor errors in measurements of ring spacing and shim height differences this does not necessarily move your shot impact that amount. It seems like it should, but it doesn't always work out that way. Also, you mess up the nice scope seat that you should have established by lapping in the rings. Therefore, I suggest a steel shim that fits in the bottom of the rear ring, epoxying it in place and re-lapping. Anyone with a better idea would gladly be heard from.

On the matter of scope power, I find that 12X is plenty good for nearly all shooting, but a capability of up to 20X or even more is necessary for the 800 yard and longer ranges on small targets like half grown prairie dogs. They blend into background with lesser powered scopes.

Fixed powers of high magnitude will drive you nuts on some days with bad mirage, and they limit field of view too much at the closer ranges.

I hope to have many more days of no wind, as there are a lot of things I wish to try. The wind hardly ever blows here in Montana. Your check is in the mail.

HOW I CHANGED MY STAND

by

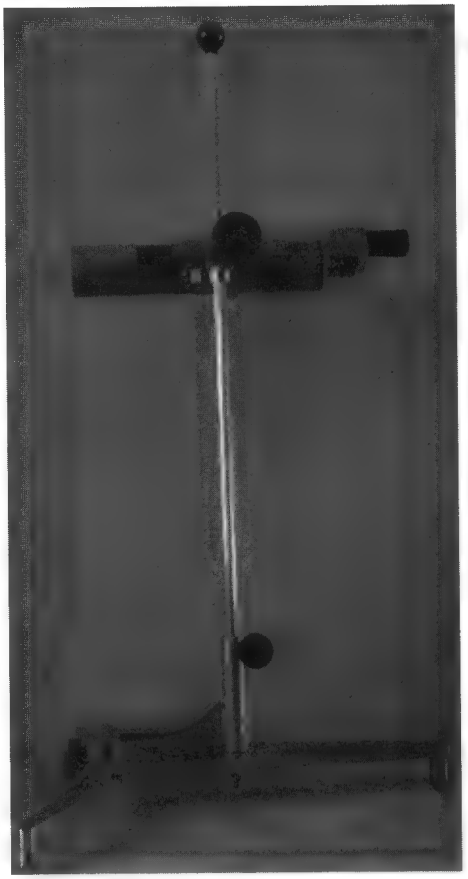
Bud Salyer

Can you remember going to your first rifle match at Camp Perry? Wasn't it exciting? You arrived with your genuine Marine Corps shooting jacket with the hard rubber elbow pads that fit you like a.... sack, and which supported you like a.... sack. You had a Garand that looked like it had been salvaged from the beaches of Iwo Jima. You had pilfered around and found a piece of good carpet pad for a shooting mat, and you had acquired a brilliantly white Tasco scope about four feet long that was mounted on a tripod... eight inches high. As you checked in, you didn't have a clue that when Monday morning came, you would go to the line looking like a paddle-foot dork, or pencil-necked geek, whichever is worse.

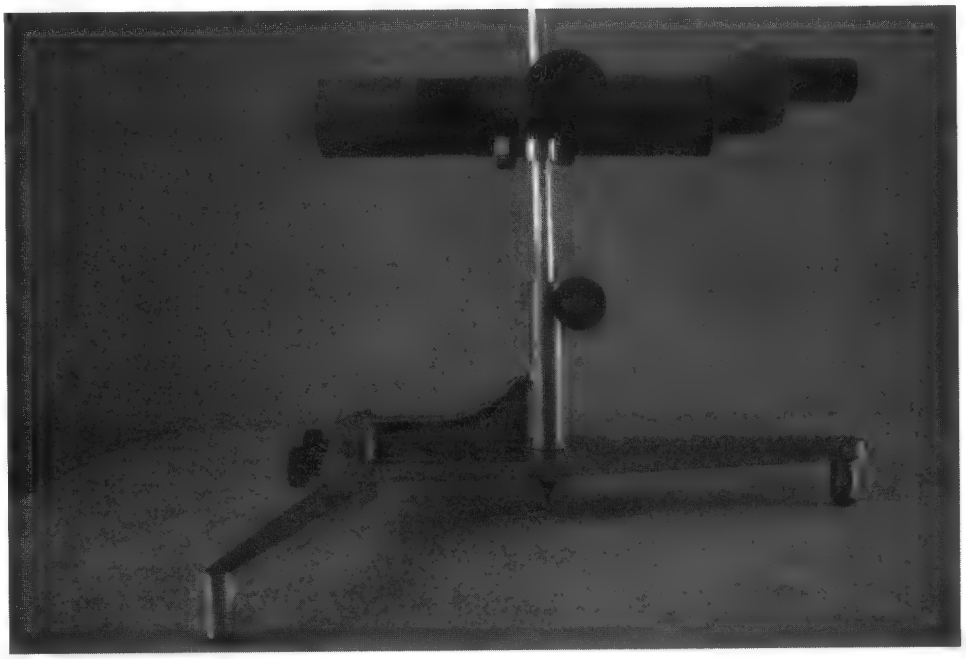
Then came Monday. You walked the ready line, curious to see how everyone else was equipped and saw all the neat gear spread out on the ground. Well!!! No wonder you were shooting Marksman scores. You didn't have the.... *right equipment*. I mean... look at that guy over there. You had seen him in *American Rifleman* and his jacket... my God, his coat is made out of leather. With buckles on it, no less.

You were suddenly.... *embarrassed* by

Continued on next page



Ready to go, high scope position.



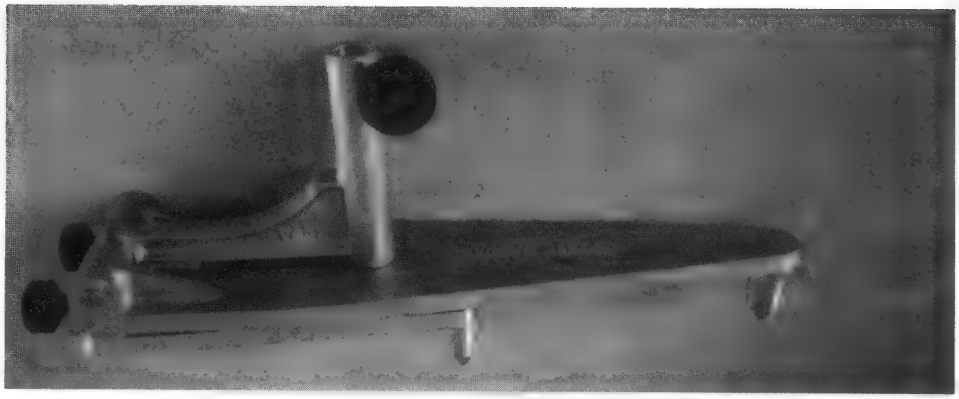
Ready to go, low scope position.

HOW I CHANGED MY STAND

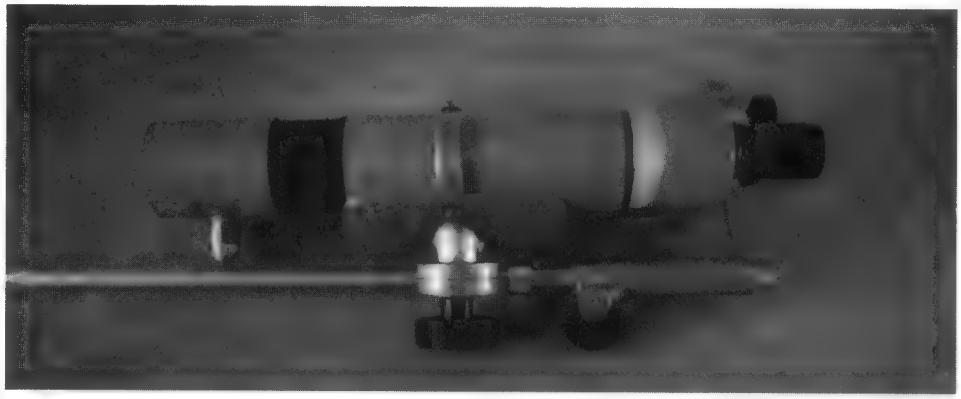
Continued

the dinky long scope and stand you picked up at K-Mart. As other competitors came by and noticed your equipment, you skulked away and tried to disassociate yourself from that.... garbage.

Well, there was a solution to that. At the end of the day, you rushed down to Commercial Row and bought yourself a.... Freeland scope stand. You had seen some of the top names in shooting carting them around, so they must be... ***the right stuff.*** As a matter of fact, everyone — absolutely *everyone* — had a Freeland. Back to the hut. You prepared to mount your dinky scope while trying to figure out how to explain this expense to your wife. ***[NOTE: You didn't replace the actual scope until Tuesday evening: "Honey, I know it cost a lot, but I got up there and the mirage was so bad — you wouldn't believe the mirage — that I couldn't see to sight in." You didn't acquire The Leather Shooting Jacket until Wednesday. By Thursday, you had bought a case of .308 Federal Match, and by Friday you had dropped nearly a grand on... well... essentials. You looked at all your gear and thought about how much your scores would improve before your next match.]***



Device disassembled, lower portion.



Device disassembled, top portion.

Now, back to the Freeland. Where are the instructions for mounting the scope on this Freeland stand??? There aren't any??? Back to Commercial Row. Ask the man how to do it. In between helping fit a leather jacket and explaining the wonders of a $400.00 scope, he says: dah-dah-blip-blip-dowhatchit. Didn't quite understand it, but you thought you had the basic picture. Didn't want to sound stupid asking someone to explain a.... *Freeland scope stand.* I mean, every shooter at Camp Perry understood The Freeland Scope Saddle, didn't they? Everyone except you.

Back to the hut. Let's see, "Put the Allen wrench here and.... hey, guys, anybody got a pair of water pump pliers? No? Well, if I wrap a towel around this nut and twist... alright. Got it."

Tuesday. Back to the line, bright and early. That Freeland scope stand would make at least a three point difference in your average score. Relay one to the firing line. Scope set up. Get a rough adjustment by pushing the front end down. Push a little harder... a little harder. OOPS. That was some adjustment. Kind of ratchety friction clutch there. Hell, now it's pointing at the ground 30 feet in front of the firing line. No problem, just use this dandy little adjustment knob to raise it up. Whoa. Not enough adjustment. Just have to raise it by hand. Damn!!! It just unscrewed itself. No time for the Allen wrench and, besides, who would have a pair of water pump pliers on the line? *(Well, just about everyone who has a Freeland scope stand packs a pair of pliers unless he believes in living dangerously).*

Tuesday evening. Trip into Port Clinton for a pair of water pump pliers.

Wednesday. "Let's see, rifle, ammo, shooting jacket *(have to do something about this dorky Marine shooting jacket*

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tonight), Allen wrench, water pump pliers...."

Don't you remember those days? Don't you remember all the trouble you have had trying to get that scope stand under control? What you failed to realize *then* was that the Freeland was the only scope stand on the range because it was.... the only stand available. By the time your pride let you admit that it was a genuine Rube Goldberg device, you had also come to realize that there was nothing better — simply because there was nothing else.

Not any more. I am pleased to report, dear hearts, that there is now another game in town. And it does not have the eccentricities so familiar to the Freeland.

Robert Johnson builds a stand that is simplicity itself, and after trying one for several months, I have no complaints — just praise — and am not sure where my beloved (?) Freeland is today.

The legs on a Freeland have... well, dimples on them. This stand has a broad base with three healthy spikes to hold it in the turf. Just unfold the legs and stomp. Plants it there to stay. If it should sway a little when you set up full height for off-hand shooting, it has a built-in center spike that goes clear to bedrock.

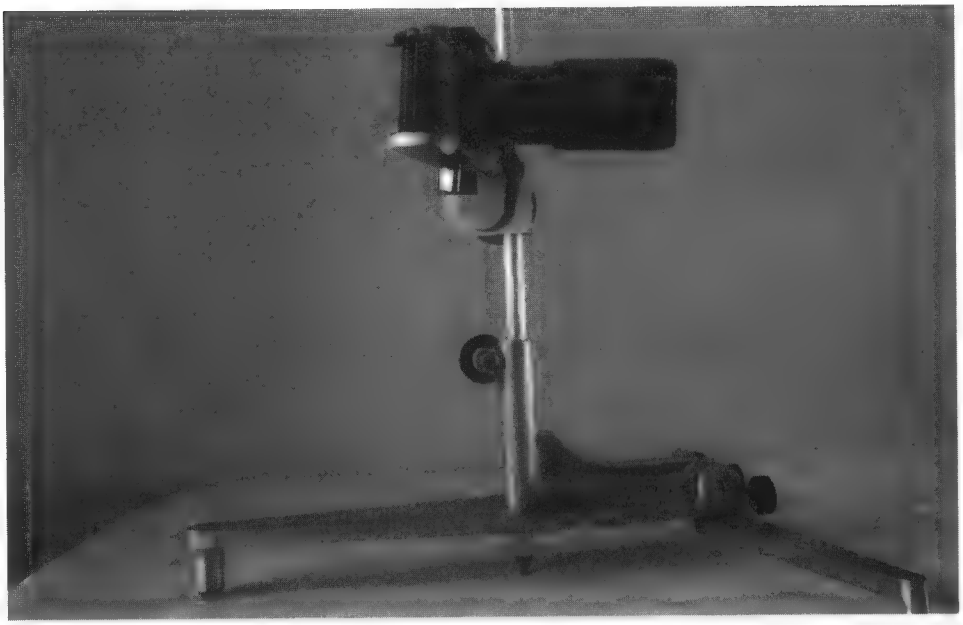
Adjusting the saddle? Loosen the knob, point it at the target and tighten. It stays there.

Do you have a small shooting cart? This thing is clean and compact. When it folds up, it doesn't have legs sticking out in all directions like antennae on a Sputnik.

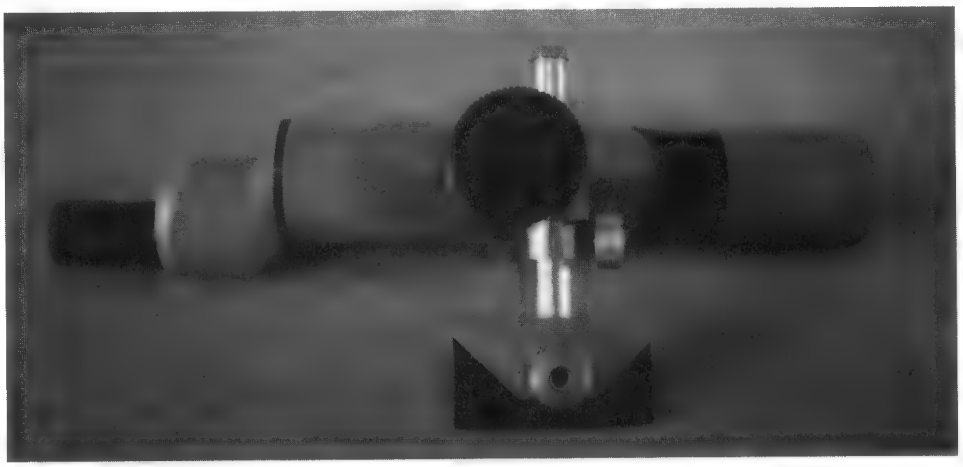
There are a couple other features available. One is a camera mount. Probably would not be as satisfactory as an actual photographic tripod, but on the other hand, it is at least as convenient. The other option is a mount for a car window to be used with the saddle. Slick little thing: just slide your scope saddle off the shaft and install in the car. Look out groundhogs.

The whole thing is cast aluminum, and therefore light, but strong. I haven't broken anything yet, and I have kicked it around quite a bit.

I can recommend it. Contact Robert V. Johnson, 919 West 14th St., Cedar Falls, Iowa 50613.



Camera adapter.



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SOME THOUGHTS ON NECK TURNING

by

Ole J. Olsen

I was having lots of trouble with neck separations with my "Lapua" brass, and was starting to believe that I must be doing something wrong. I had never had this problem with other makes of brass, even with pretty stiff loads. When I started to find a few neck-less cases at the range from other shooters, I knew I had to have a look at my case preparation technique.

Both Dick Wright and Geza Nagy have written excellent articles on case prepping, but both these gentlemen have one advice which I think is wrong. (When contradicting people with their experience and knowledge I should really say that I think that they are *not right*, not that they are wrong).

The one thing I'm referring to is letting the cutter of the neck turner cut "slightly" into the shoulder. Well, "slightly" can not be measured; it is bound to vary from person to person and it takes very little before "slightly" is "too much".

Please refer to sketch "A" to see what a case with the neck cut as described above might look like. I have exaggerated some of the areas for clarity. (My wife has told me ten million times not to exaggerate).

As shown in the sketch, if the shoulder-cut is very deep, there might be a slight gap between the shoulder/neck area and the chamber.

To know exactly what takes place inside the case on ignition, one would have to be there, I suppose, and its like guessing what happened during the first few micro seconds of the "Big Bang".

What I think happens is that the shoulder angle decreases as the shoulder/neck junction slams against the chamber as suggested in sketch "B".

As the pressure increases, the case starts to form into the chamber. Since lengths A & B are longer than C, some of the extra brass required will come from the neck/shoulder area. After the first fireforming the case will perhaps look like sketch "C".

Now, this is where the hardness of the Lapua brass works against us. While other softer, more malleable brass can handle being stretched around a sharp corner, the "thinned" shoulder of the Lapua cases can not. Small cracks start to develop, and as subsequent firings fill in the corner at the body/shoulder junction, the crack will deepen. All the broken necks I have seen have the cracks starting from the inside. If the Lapua brass survives the fireforming it's without doubt (in my opinion, at least) the best ever developed. I have not used a full size die since I started to use Lapua cases.

OK, how to turn Lapua brass to avoid the above problems? This is the heart of my method: Match the cut to suit each chamber. I'm sure I have re-invented the wheel, but since I started using my method the necks are still sound after 40 plus reloadings.

Please refer to sketch "D". I prefer a very snug fit, so I turn brass for my .262" chamber to .0092" wall thickness. I turn the neck in one pass; you have to "lean" on the cutter, but it's no big deal. When I'm about 1mm from the shoulder I start to try the case in the chamber of the gun I'm turning for (or, for which chamber I'm turning). The bolt should not turn down on the first try. The next step is to keep turning a "wee bit" at a time until the bolt closes *very hard*. Now set the mandrel at this length and take a measurement with your calipers to keep on record for this chamber. The case will now fit in the chamber as shown in sketch "D". This length usually varies from chamber to chamber, so good record keeping is important to avoid having to go through the fitting process each time.

Now, if we slip inside the case during ignition again, (I hope you get a bang out of this), I believe we will see that the case will stretch in a slightly different manner. We will probably still get some pulling around the corner at "x", (this is of course the reason for case shortening during case forming), but since the case is jammed hard against the chamber the stretching takes place mainly in shoulder area C. As sketch "E" indicates, the doughnut will form mainly in the upper end of the shoulder.

Doughnut or no doughnut, the proof of the pudding is in the eating. The cases formed the above way perform just great in my rifles. When the cases are examined with a strong magnifying glass, there is a barely perceptible ring at the shoulder/neck junction instead of the wide, ugly band resulting form "the other method".

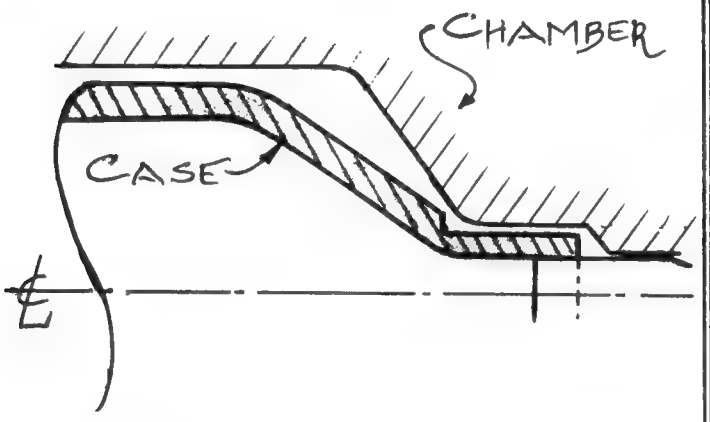
So, all that is left to do is a rousing rendition of "I did it my way".

Some *general* thoughts on neck turning:

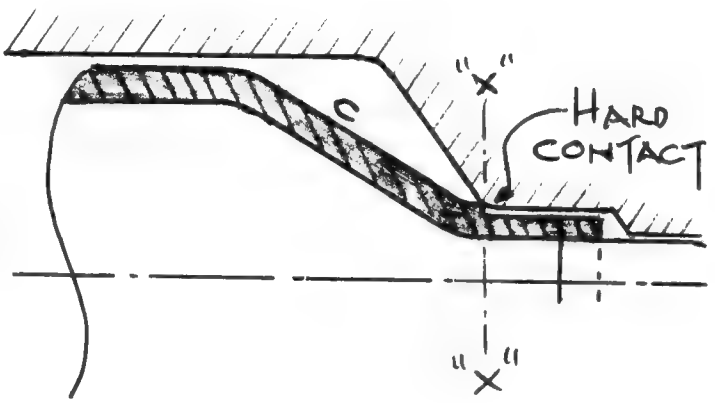
- Repeat everything exactly the same, case to case.
- Once you have started turning, don't tighten anything; it will change your end result.
- Always use the same amount of strokes for each case for expansion, etc..
- Lubrication is super important. I'm still using the old fashioned hardened steel (not the carbide) mandrels, and I don't have the slightest trace of galling. Secret? Use "Friction Block". I finally found a use for this concoction! When I turn cases I liberally douse Friction Block on the inside of the neck, outside of the neck, and on the mandrel. Replenish the outside lube as the cutting progresses. It leaves a beautiful, shiny finish.
- Don't push the cutting too fast.
- Clean, clean, clean. Wipe and inspect after each operation. Have a magnifying glass handy at all times to detect and remove minute pieces of brass which might screw up your alignment and your measurements. If you're not up to your ankles in Q-Tips when you're finished, something is wrong!
- Run the turner up the neck twice.
- Use steel wool (0000), and a bit of Shooters Choice on the neck before taking your final measurement. Again, count the turns; consistency is the secret.
- Finally, use very mild case forming loads on the Lapua brass. 25 grains of H322 is just about right.
- Have fun!

Ole J. Olsen
146 Old Chicopee Road
Kitchener, Ontario
Canada N2A 3M9

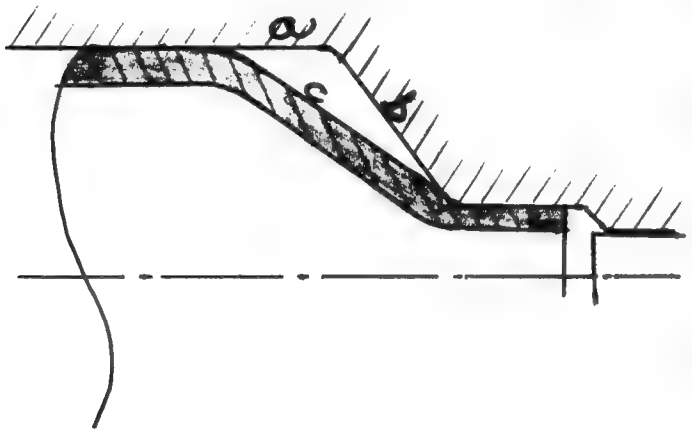
1-15



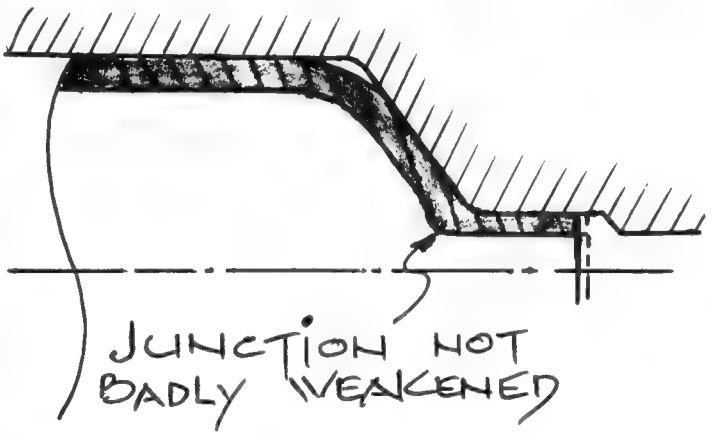
SKETCH "A"



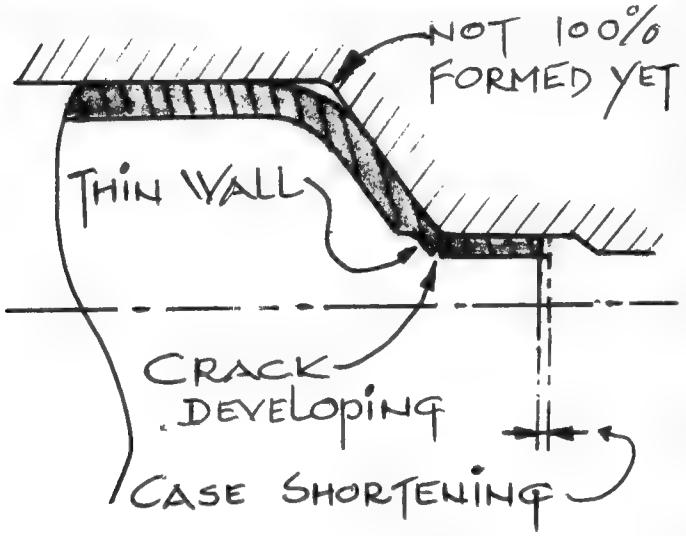
SKETCH "D"



SKETCH "B"



SKETCH "E"



SKETCH "C"

"SOME THOUGHTS ON NECK TURNING"

NO SCALE

O. J. OLSEN, OCT. 12 '94

HOW IMPORTANT IS A CENTERED/CONSISTENT STRIKER?

by

M.L. McPherson

Rare is the shooter who has not seen a gun with a misaligned striker, where the primer in the fired case shows an off-center indentation. In extreme cases, such as an old Colt Bisley revolver of mine, the indentation may be considerably off-center — my Bisley's hammer-mounted firing pin hits closer to the primer's edge than to its center.

Advanced shooters may also have considered that certain action types, such as most non-bolt rifles, do not necessarily deliver consistent striker energy. This may be especially true in some lever rifles, double-action revolvers and some pistols.

Articulated firing pin mechanisms, as used in certain lever-action rifles and some pistols, may not align identically each time the action is cycled. Finally, trigger control may affect available ignition energy in handguns fired double-action.

These subjects — off center hits and varying striker energy — have been given little non-military study, save a few handloader investigations where ballistic uniformity of specific loads and accuracy of the rifle were measured. Here I have taken a different tack: Observe visual appearance of the naked flash from primers deliberately struck off-center or with variable energy, while holding *all* other variables as close to zero as possible.

The variable energy portion of this study suggests some of the explanation of inherent inaccuracy in non-bolt rifles may be ill-directed! It is completely possible that inconsistent and limited striker energy may account for a considerable measure of any diminution of accuracy associated with non-bolt rifles.

This study also suggests that striker centering and consistency may be important accuracy goals, regardless of action type. There are things we can do to mitigate these problems. Foremost, regardless of action type, a non-centered striker is a problem any accuracy minded shooter should consider having repaired — a not too difficult gunsmithing job.

As for striker consistency and energy: There is such a thing as too much striker energy, something one should consider in any serious target rifle. . . Though this subject could not be explored here, one suspects that for any particular type of primer there is an ideal striker weight and velocity.

As an example, I once beefed up the striker spring in my Ruger #1 only to witness measurable loss of accuracy. The difference wasn't much but it was measurable. Perhaps for similar reasons I have seen superior accuracy in both 30-30 and 45-70 lever-action rifles with loads using Large Pistol Magnum primers instead of Large Rifle primers. Pistol primers have a thinner cup and are a bit easier to set off. This may have mitigated the limited energy hammer blow provided by those rifles.

Regardless of action type, consistency requires that all striker components be free of burrs and rough edges, which might catch and inhibit the piece's movement. It may be more important to insure that the assembly is free of gritty debris — sand, unburned powder residue etc. After cleaning your gun you may choose to lubricate these areas with a light gun oil but I believe the best choice for this is a dry silicone lubricant. Accumulations of residue in the bolt body have been known to render a rifle useless in very cold weather. . . oil can harden with age.

A little analysis is in order. First: Regarding non-centered hits. Keep in mind the two basic configurations of Boxer type primer anvils: Two-leg and three-leg. It is generally opined that there is little, if any, performance difference inherent in this design choice.

With centered striker impacts this may be true, however, such is evidently not the case with non-centered impacts. In this situation the three-legged anvil may possibly provide more consistent ignition.

Consider the geometry involved: In the case of the two-legged anvil the striker indentation can occur fully over the leg, fully between the legs or partially on one leg. With three-legged anvils there simply isn't room for a nominal diameter striker to completely miss any leg, this may help mitigate variations associated with non-centered impacts; then again, it may not.

Second: Concerning centered impacts with inconsistent striker energy. In this situation, perhaps surprisingly, the critical factor is primer variation. Consider CCI's Bench-Rest primers: These differ from run of the mill CCI primers chiefly in dimensional uniformity. Certainly, every effort is made to keep pellet charge as consistent as possible — one person, the best of the best, does all charging on each lot from the BR line — but the main characteristic separating CCI BR primers from regular CCI primers is dimensional uniformity. In every lot of BR primers every cup and every anvil comes from the same single production

Continued on page 91

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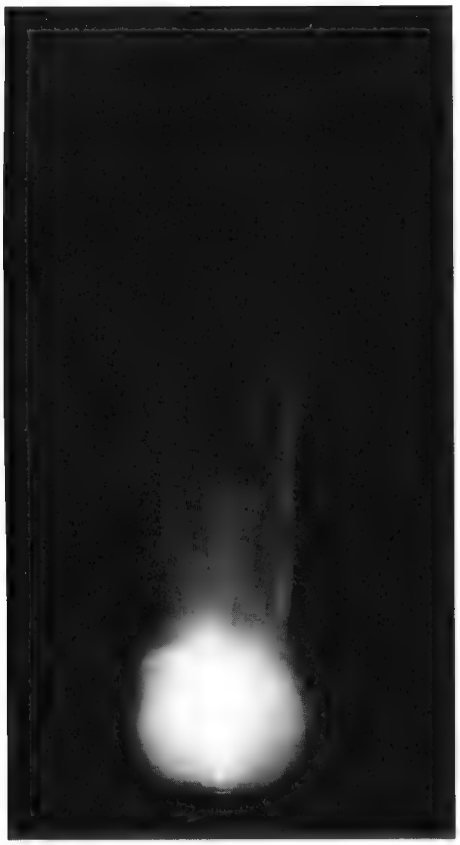
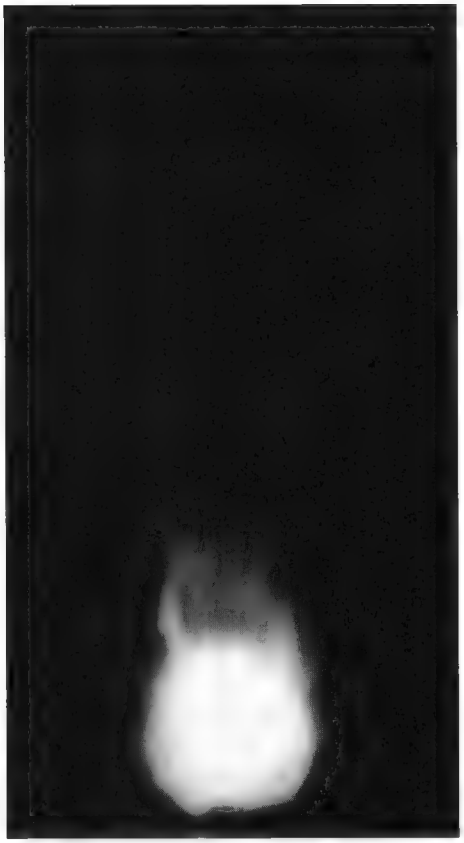
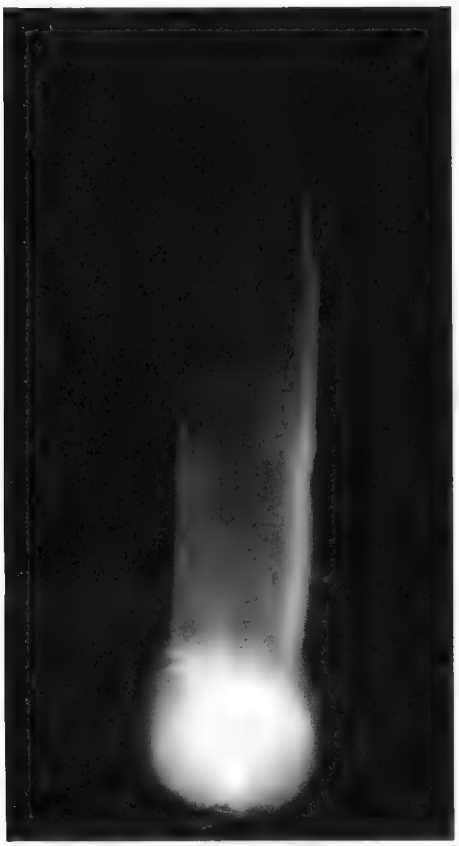


1) Fed-215
Leg centered
0.050" offset



2) Fed-215
Leg edge centered
0.05" offset

3) Fed-215
Centered between legs
0.05" offset

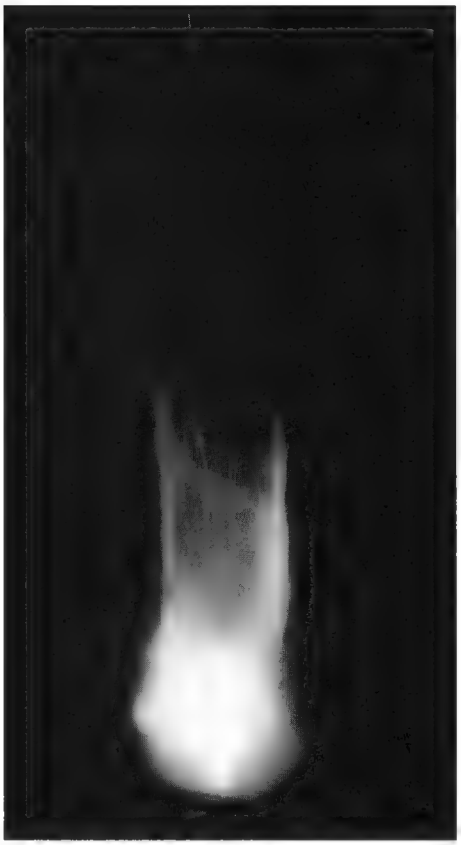


4) Fed-215
Centered
0.00" offset

5) Rem-9-1/2M
Leg centered
0.050" offset

6) Rem-9-1/2M
Leg edge centered
0.05" offset

7) Rem-9-1/2M
Centered between legs
0.05" offset



8) Rem-9-1/2M
Centered
0.02" offset

9) Rem-9-1/2M
Centered
0.00" offset

10) CCI-BR2
Centered
0.00" offset
Minimum Energy

11) CCI-BR2
Centered
0.00" offset
Low Middle Energy

12) CCI-BR2
Centered
0.00" offset
High Middle Energy

HOW IMPORTANT IS A CENTERED/CONSISTENT STRIKER?

Continued

line and they are assembled on the same single assembly line. Variation is therefore minimized, rather than being compounded, as it is when cups and anvils from several production lines are indiscriminately mixed in further processing, which happens in the non-BR primer lines.

You may fairly ask: "So what, how does that relate to variable striker energy?" It relates because consistent uniform primers held to the highest possible standards of dimensional uniformity are naturally less affected by minor variations in striker energy. Further, any resultant variation is not further compounded by internal primer variations.

Strange as it may seem it is possible that those rifles seeming least appropriate for use with BR primers, e.g., lever-actions, may be the ones which benefit most.

Finally, in the worst-case scenario, where striker impacts are both off center and inconsistent, I can only predict that one might be best served by sticking with three-leg anvil BR primers. Because of the complexity of multiple variables I did not analyze this situation for this article.

13) CCI-BR2
Centered
0.00" offset
High Energy

The test setup:

30-06 case head: Body removed, flash hole drilled and chamfered for uniformity

Two Lee case trimmer studs with striker diameter holes (one centered the other 0.05" off-center)

Lee (30-06) case trimmer shell holder

Bench mounted vise for clamping the case trimmer stud

Manual adjustable spring-loaded striker mechanism

Dark background in a dark room

Camera with 50mm lens @ f4.5 located 30" from the primers using an blocked shutter

For off-center impacts the photo perspective was ≈ perpendicular to offset direction

The off-side anvil leg toward camera (not possible in the Rem 9-1/2M leg-centered test)

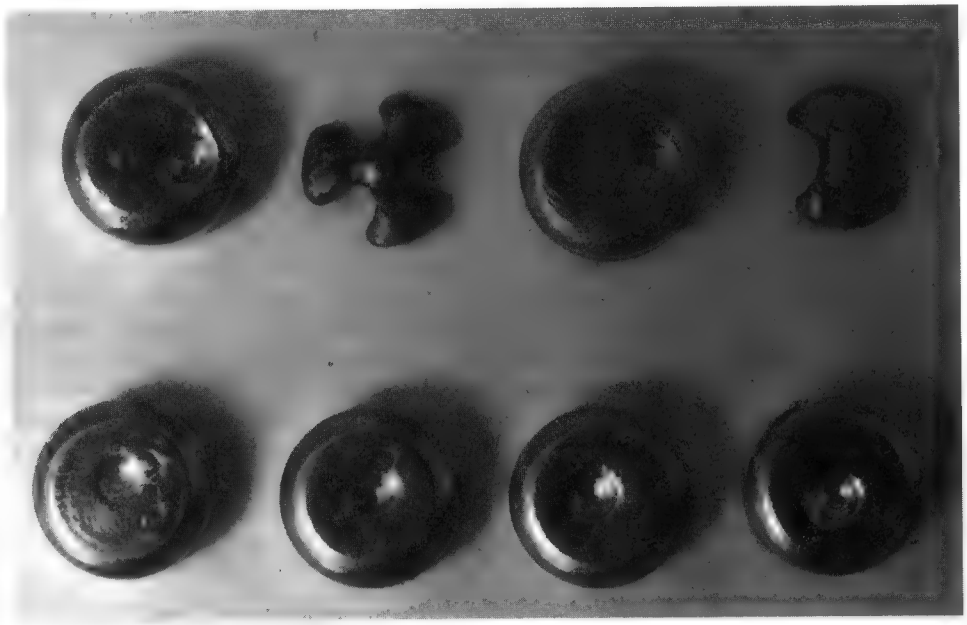
Fireball ≈ parallel to focal plane

ASA 400 color film

Prints developed to give ≈ uniform overall background brightness

For the off-center tests we used two-leg (Rem-9-1/2M) and three-leg (Fed-215) Large Rifle Magnum primers, all chosen for uniformity of appearance and weight and seated in a clean pocket with utmost care toward uniformity. All

Continued on next page



14) Representative primers and anvils

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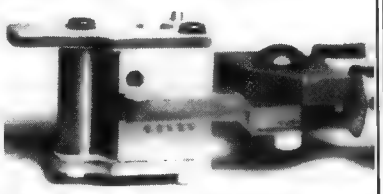

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HOW IMPORTANT IS A CENTERED/CONSISTENT STRIKER?

Continued

PRIMER Mfg./#/Type (Anvil Type)	Relative Impact Energy	Impact Offset/ Position	Fireball Volume	Diffuse Flame	Relative # of Sparks	Spark Trail Length	Comments
Fed/215/LRM (3 leg)	HIGH	0.05"/LC	16.9	50.6	L. Med.	11.7	Evident turbulence in diffuse flame
Fed/215/LRM (3 leg)	HIGH	0.05"/LE	18.8	21.8	L. Med.	13.8	Several outsized sparks trails
Fed/215/LRM (3 leg)	HIGH	0.05"/Mid	17.2	16.0	L. Med.	15.3	Several outsized spark trails
Fed/215/LRM (3 leg)	HIGH	0.00"/Cen	16.0	57.8	L. Med.	11.5	Overall uniformity evident
Rem/9½M/LRM (2 leg)	HIGH	0.05"/LC	9.9	31.4	Low	14.0	Several very large spark trails
Rem/9½M/LRM (2 leg)	HIGH	0.05"/LE	13.8	13.9	Medium	14.8	Several very large spark trails
Rem/9½M/LRM (2 leg)	HIGH	0.05"/Mid	11.3	24.7	L. Med.	13.5	Evident turbulence
Rem/9½M/LRM (2 leg)	HIGH	0.02"/Cen	12.5	29.0	L. Med.	14.0	Several large spark trails
Rem/9½M/LRM (2 leg)	HIGH	0.00"/Cen	12.2	34.5	Medium	>16	What caused the diffuse flame to bend right?
CCI/BR2/LRBR (3 leg)	MINIMUM	0.00"/Cen	5.6	19.8	High	10.1	You may be able to see a very diffuse flame extending as far as any spark (not measured)
CCI/BR2/LRBR (3 leg)	L. MID.	0.00"/Cen	6.9	23.4	High	10.0	Several very large spark trails
CCI/BR2/LRBR (3 leg)	H. MID.	0.00"/Cen	6.7	28.1	High	9.8	Wispy diffuse extended flame
CCI/BR2/LRBR (3 leg)	HIGH	0.00"/Cen	6.5	32.3	High	12.0	Extended wispy diffuse flame up one side

LRBR=Large Rifle Bench Rest, LRM=Large Rifle Magnum

Impact Offset/Position: Distance from primer center/LC=Leg Centered, LE=Leg Edge, Mid=Centered Between Legs, Cen=Centered on primer

Impact Energy: Minimum=lowest setting providing consistent ignition, L. Mid.=Low Middle (⅓ point between minimum and high), H. Mid.=High Middle (⅔ point between minimum and high), High=Maximum setting (approximately equal to a light typical rifle striker)

Fireball Volume: Approximate volume, cubic inches, of spherical dense portion of flame

Diffuse Flame Volume: Estimated volume, cubic inches, of more-or-less diffuse flame extending beyond the fireball (I tried to be consistent within each primer type, there is not consistency between types as the nature of the diffuse flame drastically differs)

Relative Spark Volume: Estimate of relative number of identifiable incandescent particles

Spark Trail length: Greatest distance, in inches, any spark reached (excepting single rogues)

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impacts were centered approximately 0.05" offset from the primer's center.

A consistent relatively high-energy striker setting, approximately equal to a typical bolt-action rifle striker, was used. For each type of primer the following impact locations were tested: Centered over an anvil leg, centered between two anvil legs and centered over the edge of an anvil leg.

For the variable striker-energy test we used CCI-BR2 (Large Rifle Bench-Rest) primers (a three-leg anvil type) and adjusted the automatic striker mechanism to the following settings: Minimum energy achieving ignition, minimum +1/3 the adjustment to maximum, minimum +2/3 the adjustment to maximum and maximum.

Rather than detail test results with further dry text I have chosen to chart the salient points — whereby one can more readily identify significant differences. Further, a picture is worth a thousand words: See for yourself, striker energy and centering does matter.

It is beyond the scope of this article to compare before and after accuracy in guns where an off center striker has been repaired. However, based on visual results of this test one can predict differences in ballistic uniformity. It is even possible that the striker hitting over an anvil leg versus hitting between anvil legs could set up different vibrations in the gun, thereby patterning to separate impact centers. Who knows?

A SHOT IN THE DARK

by

Charles H. Woolley

As an avid hunter of many seasons, I have always heard of the large objective European optics with enhanced light gathering capabilities and heavy crosswires to facilitate accurate shooting in low light circumstances. While well suited to European hunting, I never felt the need to try one out with all the excess weight and extra cost for the extra 10 - 15 minutes of hunting they might allow me here in Montana.

However, I have had a lot of contact with the plethora of illuminated, non-magnifying dot sights used in various handgun and shotgun speed shooting events and their strengths and weaknesses, due to my wife, Judy Woolley, being deeply involved in high level competition in these disciplines.

Recently, in reviewing new products I noticed that there are several offerings in the optical field that combine rifle scopes with various illuminated reticles and it occurred to me that there was a concept that might have some interesting applications in recreational, law enforcement, and military riflery. I knew from experience that the various L.E.D. electronic dot scopes with their attention grabbing illuminated aiming points and single focal plane sighting were undoubtedly the competitive edge in many of the handgun disciplines, but had limited application to precision riflery due to the relatively large aiming point of 3-4 minutes at minimum and the lack of magnification.

The rifle scopes now available are a whole different story. Here are precision optics of up to 22 power with large objective lenses combined with well defined sub-minute of angle illuminated aiming points. Very impressive technology indeed, but it begs the question, "What specialized conditions can they be applied to?" Once that is addressed the next obvious question is, "What empirical advantage can a marksman (or woman) expect?"

The applications that come to mind immediately would be for low light or perhaps moonlight hunting of varmints and for predator control, and extending effective hours of hunting in thickets, dense timber, and on north facing slopes where shooting light runs out long before legal hunting hours. Perhaps there might be some advantage in silhouette competition where a well defined aiming point with contrast would be preferable to the black reticle on a black target, and most definitely there should be some applications in low light police and military sniper use. Then again, there may be yet another viable use for them!

Is it only in Montana, or do you know people that wait 'till the last (I mean the VERY LAST) minute to sight in their rifles in the fading light of the evening before the opening day of hunting season? You see them at the range as the targets fade from view at the 100 yard firing line, touching off the final rounds with the statement, "Can you see anything??? Oh well, it should be good enough!", followed by the disclaimer, "I hope!" Perhaps these scopes will provide salvation or at least confidence in a known zero for these procrastinators.

The first stop on this intellectual journey will be to examine the technologies currently available.

The first variation is the L.E.D. illuminated reticle exemplified by the Nightforce 5.5 - 22 X 56mm A.O. which utilizes a light emitting diode to illuminate the reticle. The diode is mounted in the eyepiece and is powered by a 3 volt coin type lithium battery and has 11 settings for varying intensity. The diode illuminates the entire reticle display a bright red in the dark and does not provide any illumination when viewed in normal daylight. Under normal daylight conditions the reticle is the standard, basic black. On its highest setting when viewed against a black background in day light, the most contrast visible is but a rusty hue. Other features of note on the Nightforce 5.5 - 22 are its 4:1 magnification ratio, exceptionally clear optics and light gathering capability and a reticule layout that has a very usable set of dots and dashes with known subtension angles from the crosswire intersection that allow for precise aiming points for holdover and windage.

It also had an excellent range finding reticle using 9" circles and 18" spaces all clearly labeled in the display and giving an easy reference that was well defined and calibrated from 300 to 800 yards. It may not rival the new laser range finders for accuracy but it sure beats guessing beyond 300 yards and on a target of known size should get you in a reasonable ball park estimate, say plus or minus 25 yards depending on operator skill, visibility, and use of a *SOLID* rest. This scope was designed for night varmint hunting in Australia where low light shooting at long range on varmints is the only way to control the large numbers of feral and native pest species. It is imported by Lightforce, U.S.A., Inc., 4021 Aurora Ave, N., Seattle, WA 98103. Given its ultimate quality and features including a 30mm tube, glass etched reti-

Continued on next page

Evaluating optical quality (Nightforce 5.5-22X).

cle to ensure durability and the excellent NP1-RR range finding illuminated reticle this, while not inexpensive at a price of $788.95, is surely a good value when compared to the top line European optics. In fact I was able to see .22 caliber holes in a 3X5 card at 200 yards with it and I don't find that capability in very many optical devices. This is obviously one serious piece of equipment.

The second variation of lighted reticle utilizes an L.E.D. to project the light via a fiber optic strand, shrouded by one leg of the reticle, to achieve a sub-minute of angle red dot at the intersection of the duplex crosswire. The scope tested is manufactured by AAL Optics, Inc., 2316 N.E. 8th Rd., Ocala, FL 33470 and is their highest power model , a 4 - 12 X 56mm A.O. MicroDot with its L.E.D. again contained in the eyepiece and powered by the ubiquitous 3 volt lithium coin battery. The intensity is adjustable in 11 settings and at its highest the red dot is clearly visible on a black target in normal daylight conditions. This scope uses the traditional American standard 1 inch tube. Optically, it has a clear center field of view with some halo at the outer edges of the field on 12 power. While it is not quite in the same category as the Nightforce in terms of optical excellence, it is certainly a solid optical value at a price of $409.00 suggested retail. The MicroDot weighs in at 21 ounces which makes it a reasonable choice in situations where a scope and rifle will be carried much and shot but little as in big game hunting. The ability to see the aiming point clearly against dark targets in daylight may give some advantage if employed in metallic silhouette competition.

The third available technology is the use of radioactive tritium to illuminate the reticle display under low light situations. This is employed by Trijicon, Inc., P.O. Box 6029, 49385 Shafer Ave., Wixom, MI 48393. While my intention was to include a test of their model TR10 8 -24 X 56 A.O. with a 30mm tube, unfortunately it was not available in time to incorporate in this article. Salient points to consider is the fact that this item does not depend on electronics or batteries to illuminate the reticle. It is illuminated by the tritium capsule at all times but the illumination is only evident in very low light and then provides a very usable level of illumination without being bright or "flaring". The tritium is guaranteed for 10 years minimum service life. While I cannot comment on the quality of this scopes optical layout first hand, I would assume that one could expect quality, as the price I have heard is in excess of $1200.00.

Intuitively, one feels that these scopes could show definite advantages in the formerly mentioned circumstances but being a conservative sort as well as a skeptic at times I felt the need to get some quantitative measure of performance as well as to become acquainted with the parameters involved in very low light shooting. So, setting aside the advertising claims and enthusiasm for high-tech equipment, I followed the way to true knowledge down the path to the range to explore the realm of 56mm objective equipped scopes with illuminated reticles.

Equipment for testing consisted of a buff target board with a 3 inch black circle as an aiming point, a Clark Custom 10/22 Ruger with the fine Burris Zee rings for ease of mounting to the Weaver type base, sandbags, CCI Green Tag ammunition, pen, paper, and flashlight. Why test with a .22 and standard velocity ammunition? For safety sake, I didn't want to risk the longer shots in very low light at longer distances, as doing so would take me outside the range where I was positive that nothing could access the range without my knowledge. The other reason was to minimize the rejection of this exercise by neighbors and the subsequent attraction of law enforcement personnel due to excessive muzzle blast during hours when only a fool or crazy person would be shooting. (Please reserve your comments, I know what you are thinking.)

Baseline data was obtained by shooting at 6, 12, and 16 power under normal daylight conditions to obtain 5 shot groups at each setting from a sandbagged rest at 75 yards. This whole test program falls into the category of "Kids, don't try this at home!" If anyone cares to try this be advised to make serious assessment of your range and procedures in terms of safety and the security of the range used from inadvertent intrusion over the distance being shot. Safety should be your utmost priority! If there is any possibility of a safety problem, it's not worth the risk.

Low light testing was done at 6X and 16X unless a scope did not go that high, in which case it was tested at its maximum magnification. This was conducted, not as a direct product comparison, but to examine the hypothesis that an illuminated reticle may have an advantage in low light conditions and generally to quantify that advantage and examine the parameters that affect scope performance in low and very low light. In the accompanying chart you will notice that there are notations for "not visible" which means that at the magnification noted in that column and with the scope used and illumination intensity noted, the aiming point could not be distinguished enough to allow even a poor guess as to reticle placement.

The other notation you will note is "fadeout". Fadeout is my own term for the visual phenomenon experienced when placing a lighted reticle on an otherwise visible target and literally watching it fade away as your pupil constricts due to the light issuing from the illuminated reticle. If the target was not visible, either the magnification was increased in an

attempt to allow visualization of the target, or if that was not possible, the group was not fired.

As the parameters with which I was working became apparent, such as the pupils constriction when subjected to light from the reticle with subsequent target "fadeout", I developed a technique that allowed a window of about 1 second in which a reasonable shot could be fired. This technique I call the "blink". It involves visualizing the target in the scopes field of view in an area offset from the illuminated display. Then move the reticle to the center of the target area before the "fadeout" occurs, making sure the rifle is firmly rested on the sandbags. Then close both eyes to allow the pupils to dilate. Then hold enough pressure on the trigger to be just short of firing. Open the eyes, make a final alignment, and fire the shot before the target fades out completely, which will occur in .25 to 1 second. Repeat the "blink" if alignment, trigger preparation, or window of opportunity was too short. This may not be an optimum circumstance for accurate shooting, but if not employed under quite dark conditions an aimed shot was impossible.

Other terms on the chart that need to be defined are LLSL, an abbreviation for, "Last legal Shooting Light," and "Moonlight". LLSL is defined as being able to distinguish the target board with the naked eye but not being able to distinguish the 3 inch aiming bull at 75 yards. In other words, without the optically aided eye, you could be sure if there was a deer there but you sure couldn't be sure if it carried antlers or not. This might stretch the legal definition in some jurisdictions but for my purposes here we are only trying to get a definition of lighting conditions that can be replicated for purposes of testing. The other term is, "Moonlight". This is defined as the light provided by a clear half-moon in the moderately wooded setting of my range. Visually, you could see well enough to walk without bumping into trees or falling over stumps but you could not make out the light buff, 18 X 24 inch target backer with the unaided eye at 75 yards.

As the testing proceeded, with yours truly, visually and intellectually "operating in the dark", parameters with which I had to work became readily apparent. The "fadeout" phenomenon and need for visually defined test conditions have already been discussed. Light gathering ability and magnification also were noted as important factors. Light gathering power is no longer an abstract bragging point in your optical gear after the sun goes down. You need all you can get coupled with superior optical quality for target definition as the lights go out. Scope magnification also plays an important role.

Classic Weaver K-4 on Winchester Low Wall dwarfed by the Nightforce 5.5-22X (center) and Micro Dot 4-12X (foreground).

As magnification increases, so does the target area relative to the aiming point. This aids in defining the aiming area and its center more precisely in poor light. On the other hand, due to the poor visual reference provided by a darkened landscape, if I exceeded 16 power under test conditions it became a matter of random scanning to locate the target rather than honing in using visual cues. Operating above 16 power narrowed the field of view sufficiently to deny enough peripheral reference points to make it difficult to locate the aiming point. Therefore, the decision was made to test at 16 power as the best compromise for a practical setting to allow normal target acquisition with the maximum of target definition. It seems like you just can't get a good free lunch anymore.

After compiling results and learning such techniques as the "blink", it was quite interesting to review the chart to see what conclusions could be drawn from "shooting by Braille". The first conclusion is that under LLSL conditions, given a scope as good as the Nightforce, you can shoot close to as good a group with the standard crosswire as you can with the various illuminated displays. The second conclusion is that at LLSL with the optics tested, you can expect to produce groups averaging 64% larger than the control groups at all magnifications. It will also be noted that the groups shot at 6 power were much more random in size and inconsistent than those shot at 12 and 16 power and that consistency showed a positive correlation to an increase in magnification. Overall group size showed a decrease as magnification was increased. This leads me to believe that a magnification of 10 - 12 power is necessary in order to maintain consistency of accuracy in low light.

Moving on to the results of shooting in moonlight, it became readily apparent that to see the target at all, it was necessary to utilize the maximum magnification with minimum illumination. The plain crosswire group for the Nightforce used to get a baseline comparison was 4.35 times the daylight group and could only be obtained at 16 power. Moving on to the Nightforce with reticle illuminated at its lowest setting (#1), again it could only be tested at 16 power due to fadeout at lower settings due to the brightness of the display relative to the visual size of the target. However, it did turn in a very creditable group size 2.3 times the size of the daylight baseline at 1.67 inches compared to .72 inches, and only 1.4 times the size of the average LLSL groups fired at 16 power. Remember now, we are talking dark here!

In moonlight the Micro Dot also needed maximum magnification in order to define the aiming point and at 12 power allowed me to shoot a group of 2.17 inches, 2.6 times the daylight control fired at the same power. Again very creditable considering we are shooting in the dark with no artificial light.

To add a little perspective here, a point not made by examining group size was that in general for all groups, using illuminated reticles under LLSL and Moonlight

Continued on next page

A SHOT IN THE DARK

Continued

conditions, 4 out of each 5 shots in a group were clustered into a group very close to 1" and the group enlargement was caused by a single shot outside the group. In other words, it might be concluded that under given conditions there is an 80% likelihood that any single shot fired would fall within or very close to the expected group size fired under daylight conditions using this same equipment.

It could also be concluded that it is necessary to use the illumination only on its lowest setting and magnification of at least 12 power to achieve these results.

I haven't spent 10 years gunsmithing, coaching and doing technical research to give my wife the edge to compete at the top level money matches such as Bianchi Cup, Steel Challenge, I.P.S.C., Masters International, and Sportsman's Team Challenge for nothing though.

It occurred to me that these are electrical devices powered by 3 volts and in very low light in order to get the best results we are using the lowest illumination with 12 - 16 power magnification and still having problems with target fadeout. Logically, I figured that if the illumination could be reduced further, you could perhaps expect even better results. In that spirit I made an adapter to hold a 1.5 volt battery correctly between the contacts and repeated the tests with both scopes running at half voltage.

With 1.5 V, under moonlight conditions, it was still quite easy to see the displays but with the decrease in brightness, the targets remained visible and thus shootable all the way down to 6 power. At 6X the Nightforce turned in a group of 1.5 inches and the Micro Dot 2.2 inches and with only a moderate fadeout of the target that responded well to the blink method. At maximum magnification of 12 power the Micro Dot turned in a 1.5 inch group and the Nightforce a 1.4 inch group at 16 power. I suspect that the lack of difference between the Micro Dot at 12X and the Nightforce at 16 X was probably due to the size of the display in the Nightforce causing an increase in light transmission to the eye causing papillary constriction compared to the Micro Dots unobtrusive single aiming point.

I spoke to Jeff Huber at Lightforce U.S.A. and he informed me that in the future they will be providing an even finer reticle and display with decreased intensity and in green as opposed to the current red in order to provide even better low light definition with less constriction of the pupil. This definitely sounds like a change that will further enhance the Nightforce line for low light use.

Regarding the Micro Dot, I believe that

Continued on page 98

Illuminated Reticle Scope Test Results

Magnification	6x	12x	16x
Daylight Baseline	.91"	.82"	.72"
Last Legal Shooting Light			
Nightforce, Crosswire	1.45"	1.37"	1.24"
Nightforce, Illuminated 3V - #1	1.24" (Excellent contrast, crosswire dull red)	—	1.18"
Microdot, Illuminated 3V - #1	1.82" (Dot bright, flared appearance)	1.32"	—
Nightforce, Illuminated 1.5V - #1	1.67" (Poor contrast at 6x compared to 3V test)	—	1.13"
Microdot, Illuminated 1.5V - #1	1.25" (Excellent contrast, well-defined)	1.35"	—
Moonlight			
Nightforce, Crosswire	Crosswire not visible	Crosswire not visible	3.12"
Nightforce, Illuminated 3V - #1	Target fadeout 100%	Target fadeout 100%	50% target fadeout, 1.67" used blink method
Microdot, Illuminated 3V - #1	Target fadeout 100%	50% target fadeout, 2.17", used blink method	—
Nightforce, Illuminated 1.5V - #1	50% target fadeout, 1.51", used blink method	—	50% target fadeout, 1.41", used blink method
Microdot, Illuminated 1.5V - #1	75% target fadeout 2.21", used blink meth.	50% target fadeout 1.50", used blink method	—

A Rare Problem with Some Belted Cases

by

Jay Turner

A topic which has come up in the past few months concerning belted case problems has me a bit puzzled, but I'll try to provide an explanation and a solution or two. It's a subject I did not directly address in my chapter in the PS Reloading Guide, but it apparently concerns some shooters, so here goes...

The subject is what some call the "secondary belt" which can apparently form on belted cases sized to headspace on the shoulder. If the chamber and case dimensions are just right, the case body directly in front of the belt can expand into the chamber's belt cutout, creating a tiny secondary belt. This secondary belt is not touched by the full-length sizing die, and with time it can cause difficult chambering, especially if the bolt head is not perfectly square to the chamber.

Now I say that this secondary belt "apparently" forms because I've been unable to produce the effect on demand. Still, I've read about it for years and have heard word-of-mouth references to it for almost as long, so there must be something to it. I had experienced a chambering problem years ago with a Ruger M77 .300 magnum which may have been caused by a secondary belt, but at that time I was not a very experienced handloader and wasn't looking for that problem. I "solved" the difficult chambering by changing to new cases of a different brand and did not see the problem again in this long-gone rifle.

Still, I wanted to experience the problem now so that I could analyze it and find a solution. I used three rifles chambered for belted cases, a Savage M116 in .338 Winchester Magnum, a Remington M700 in 7 mm Remington Magnum, and a Ruger Number One barreled by Jarrett in .257 Weatherby. I used twice-fired cases which were neck-sized only, this to insure that they indeed did headspace on the shoulder. In each instance I took my normal maximum load and increased it by three grains to make certain that I had enough pressure to deform the case. While my maximum loads are as hot as I want to shoot on a regular basis, I'm aware that some shooters aren't happy with a load unless they have to hammer open the bolt to extract a fired case. This propensity to use very high pressure loads may in part account for the secondary belt — I wanted to find out.

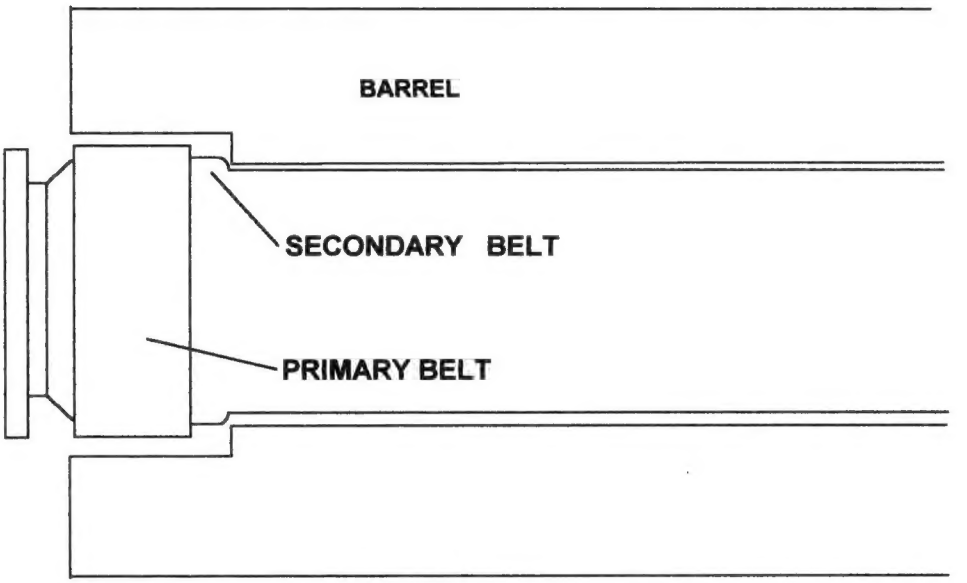

FIGURE 1: When a belted chamber has excessive headspace, but the case is sized to headspace on the shoulder, there is a gap between the front of the belt and the front of the chamber cutout. If the case is extruded into this space a "secondary belt" is created.

I was satisfied that the test loads produced ample pressure, as the two bolt guns spit out cases with strong ejector tattoos on the case heads, and they required some effort to open the actions. The Ruger won't produce an ejector mark on the case head of course, but the test load did require plenty of effort to open the action. Surely these test loads produced adequate pressure to deform the case walls.

Back at the bench I closely examined the fired cases with a strong lens, and lo and behold there were no secondary belts to be seen on any of them. To be certain, I repeated the test with the same cases and loads, but no secondary belts developed then either. Does this mean that the secondary belt effect is a myth with no substance?

No, I don't think so. One test parameter I failed to mention was my use of strong modern belted cases by Remington and Federal. These makes, at least the recently manufactured cases I've cut open and examined, have thick webs behind the belts and stout case walls. They provide greater support for the case than the rather thin webs and walls of some other brands of brass, perhaps most notably the soft Norma-made Weatherby cases of the 1960s and 70s. While I had none of the lighter cases to test, I will propose that this thinner brass may indeed allow the case to expand into the belt cutout to produce the secondary belt.

If you think about it, this thin case scenario makes plenty of sense. Many handloaders measure the expansion ring on their fired cases to help gauge chamber pressure. This ring forms when the

Continued on next page

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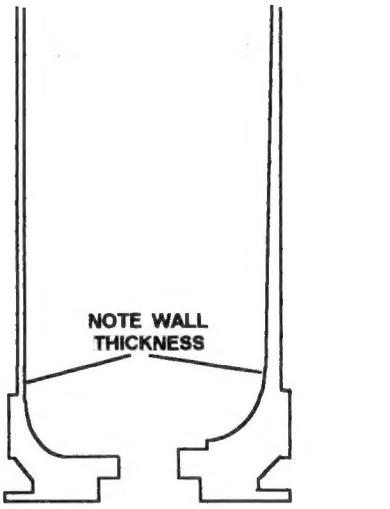

FIGURE 2: Numerous belted case problems can be treated by switching to a heavier, thicker case. The case on the left gives much less support to the belt and the case wall just in front of it, allowing chamber pressure to more easily deform the case. By using a heavier case like the one on the right the handloader greatly reduces the chance of case deformation in these areas.

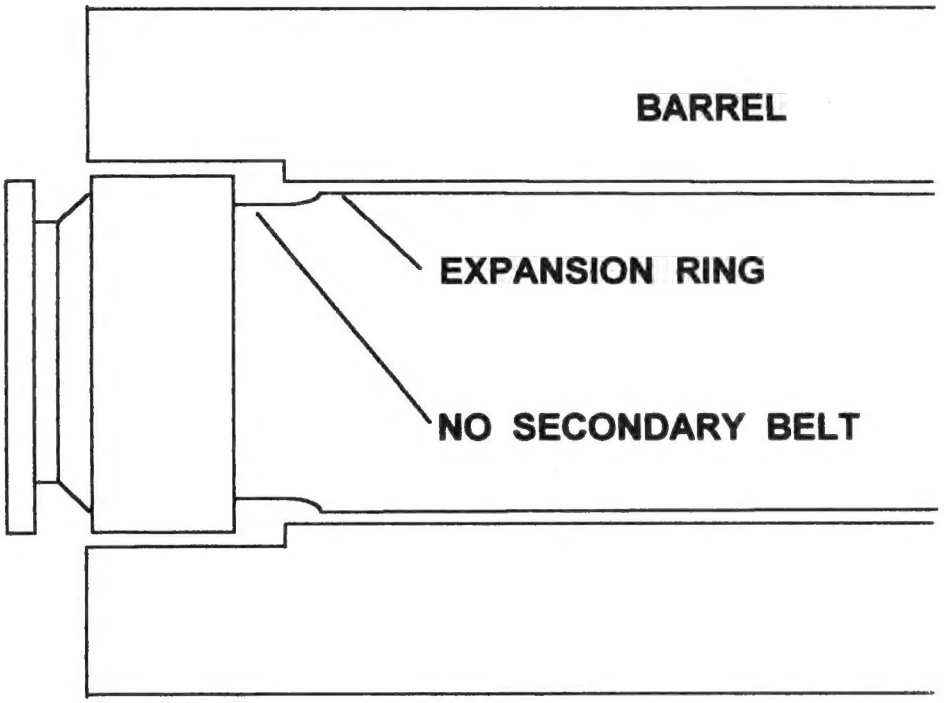

FIGURE 3: The only way that a secondary belt can form is if the case is extruded into the belt cutout. Many handloaders measure the expansion ring on their cases to estimate relative chamber pressures, but if the expansion ring doesn't reach back to the belt cutout there is little chance that a secondary belt will be produced.

A RARE PROBLEM WITH SOME BELTED CASES

Continued

case web ahead of the solid head expands to conform to the chamber walls. As chamber pressure increases the case wall expands closer and closer to the solid case head because the increasing force is deforming the thicker brass. Due to the body taper of most case designs, as the expansion ring moves rearward with increasing chamber pressure the diameter of the chamber, and the resulting ring, increases. This gives the handloader a rough guide as to the relative chamber pressures of his loads in his rifle.

The above has little to do with our discussion here except that in order for the secondary belt to form the case wall has to exceed the diameter of the normal pressure ring in order to be extruded into the belt cutout. If you measure the expansion rings of your belted cases, or even just examine them closely, you'll seldom notice that they extend all the way to the front of the belt. If they don't extend nearly that far, a secondary belt cannot form.

At the moment I'd have to recommend that shooters having a secondary belt problem should cut open one of their cases and observe the thickness of the brass just ahead of the belt. Then cut open a new Remington or Federal case and look to see if the case wall is noticeably thicker. A simple change to heavier brass may prove to be an easy solution to this apparent problem. If that doesn't work, then a return to sane chamber pressures should.

Note I've not said that just because I couldn't produce a secondary belt on demand that the phenomenon doesn't exist. I'm certain that with the correct combination of chamber and case dimensions, case thickness and hardness, and a high enough chamber pressure a secondary belt can be extruded. I'd welcome input from PS readers recounting their own experiences with secondary belts, both positive and negative. I'd just hope that anything submitted will be based upon actual experience rather than simply repeating what was read in the June 1963 issue of Shooting and Blazing, or what Uncle Joe recounted about the tenth-place shooter in the 1956 Wimbledon and his comments on the subject. It's through positive dialog that we'll all learn more about the often puzzling subject of belted cases and their idiosyncrasies.

A SHOT IN THE DARK

Continued

with its already small illuminated dot, if night shooting was on my menu, all I'd do is adapt it for the 1.5 volt battery and proceed knowing that at its lowest setting I'd be getting the maximum low light performance possible from that unit and switch back to the 3 volt if shooting metallic silhouettes or hunting big game very early or late in the day was on the agenda.

In summation, this has been a most interesting project and has been quite enlightening to become aware of the parameters that need to be considered in choosing low (or no) light shooting optics and some of the visual techniques you can use to maximize performance. It is also amazing to find that you can indeed maintain very practical accuracy at very low light levels if you choose quality illuminated reticle optics that suit your recreational or professional needs and take the time to learn how to get the best out of them under a variety of conditions. I can unequivocally conclude that the illuminated reticle is not just a gimmick. It definitely fills a performance niche that had not formerly been addressed and that niche is for those that want to take an accurate shot in the dark.

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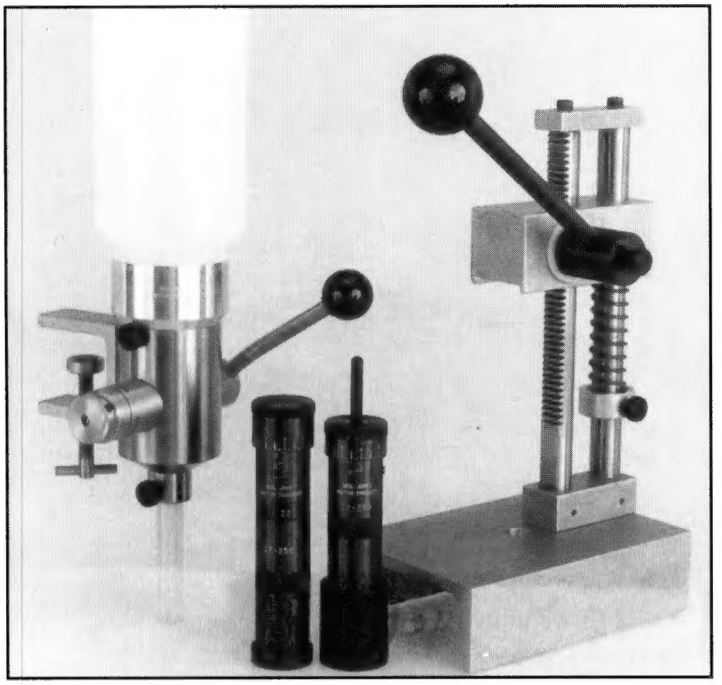

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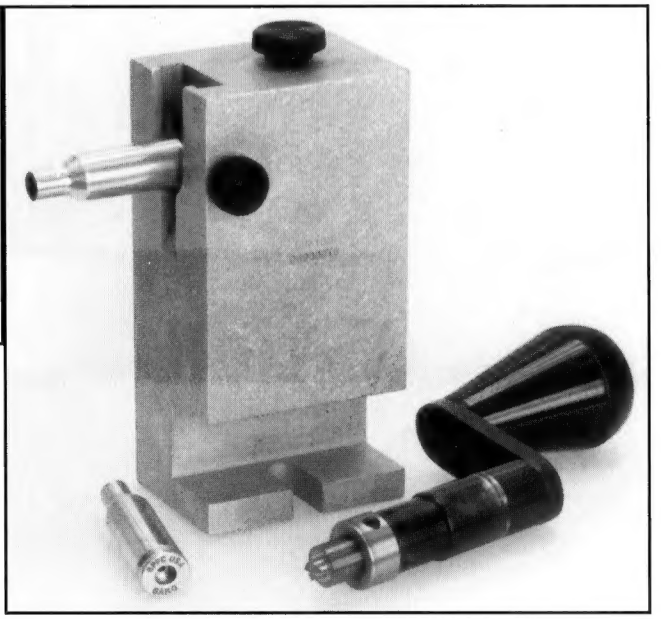

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